Mini Review
Volume 14:01, 2023

Journal of
Nuclear Medicine & Radiation Therapy

ISSN: 2155-9619 Open Access

Assessment of Spatial and Dosimetric Accuracy of a 0.35 T MR-Linac Using a Modular Phantom and PG Measurements

Lukas Nierer*

Department of Radiation Oncology, University Hospital, LMU Munich, Marchioninistr 15, 81377 Munich, Germany

Abstract

Polymer gel dosimetry is a promising technique in radiation therapy to measure and verify the delivered radiation dose. It is a three-dimensional dosimetry method that uses a polymer gel as a dosimeter. This gel is made up of a mixture of monomers, initiators and other chemicals that polymerize when exposed to radiation. The polymerization process changes the optical density of the gel, allowing the dose distribution to be visualized using magnetic resonance imaging (MRI).

Keywords: Radiation • Polymer • MRI

Introduction

MR-guided radiotherapy (MRgRT) is an emerging treatment modality that combines the real-time imaging capabilities of MRI with the precise delivery of radiation therapy. This technique allows for the visualization of soft tissues and organs in real-time, which can help clinicians to adapt the radiation treatment plan to changes in the tumor and surrounding tissue. MRgRT is especially useful for tumors in organs that move, such as the lungs and liver and can reduce the risk of toxicity to nearby healthy tissue. To evaluate the accuracy of MRgRT, a multimodality phantom can be used. A multimodality phantom is a device that mimics the properties of human tissue and can be imaged using multiple imaging modalities, such as MRI, computed tomography (CT) and positron emission tomography (PET). By using a multimodality phantom, the accuracy of the MRgRT system can be evaluated and compared with other imaging modalities. Polymer gel dosimetry can be used in combination with a multimodality phantom to evaluate the accuracy of MRgRT. The gel can be placed inside the phantom and irradiated using the MRgRT system. The dose distribution can then be visualized using MRI and compared to the expected dose distribution. By comparing the measured and expected dose distributions, the accuracy of the MRgRT system can be evaluated [1,2].

Literature Review

Studies have shown that polymer gel dosimetry combined with a multimodality phantom can provide accurate and reliable measurements of the dose distribution in MRgRT. The technique has been used to evaluate the accuracy of MRgRT systems for various types of tumors, including lung, liver and prostate cancer. Polymer gel dosimetry combined with a multimodality phantom is a valuable tool for evaluating the accuracy of MR-guided radiotherapy systems. The technique allows for the visualization and verification of the delivered radiation dose, which can improve the safety and efficacy of radiation therapy. As MR-guided radiotherapy becomes more widely adopted, the use of polymer gel dosimetry is likely to become more common in clinical practice [3].

Magnetic Resonance-guided Linear Accelerator (MR-linac) is an emerging technology that combines real-time imaging capabilities of MRI with the precise delivery of radiation therapy. The combination of these two technologies enables the adaptation of radiation therapy in real-time, which can improve the efficacy and safety of the treatment. However, the accuracy of MR-linac needs to be evaluated to ensure that the delivered radiation dose is within an acceptable range [4].

Discussion

One method to assess the accuracy of MR-linac is by using a modular phantom and polymer gel dosimetry (PG). A modular phantom is a device that mimics the properties of human tissue and can be used to simulate the treatment of different types of tumors. Polymer gel dosimetry is a three-dimensional dosimetry method that uses a polymer gel as a dosimeter. The polymer gel changes its optical density upon exposure to radiation and the dose distribution can be visualized using MRI. A study was conducted to assess the spatial and dosimetric accuracy of a 0.35 T MR-linac using a modular phantom and PG measurements. The study used a modular phantom that consisted of multiple interchangeable modules that could be assembled to simulate the treatment of different types of tumors. The phantom was filled with polymer gel dosimeters, which were irradiated using the MR-linac [5].

The PG measurements showed high reproducibility, indicating that the method was reliable for measuring the delivered radiation dose. The study found that the MR-linac performed well in a non-adaptive setting in terms of spatial and dosimetric accuracy. However, larger mean deviations were found in the mid-dose range compared to the high-dose region. The study concluded that the combination of a modular phantom and PG measurements is a useful method for assessing the accuracy of MR-linac. The results of the study can be used to optimize the treatment planning process and improve the accuracy of MR-linac. The study also highlights the importance of evaluating the accuracy of new technologies such as MR-linac, to ensure that the treatment is safe and effective for patients [6].

The use of a modular phantom and PG measurements is a reliable and accurate method for assessing the spatial and dosimetric accuracy of a 0.35 T MR-linac. The method can be used to evaluate the performance of MR-linac and optimize the treatment planning process. As the technology of MR-linac continues to evolve, the use of modular phantom and PG measurements is likely to become more prevalent in clinical practice. The objective of this study was to validate the effectiveness of a new phantom for use with a 0.35 T MR-linac and measure its reproducibility and reliability. To achieve this, we conducted PG measurements on each phantom twice. In contrast to Pappas

***Address for Correspondence:** Lukas Nierer, Department of Radiation Oncology, University Hospital, LMU Munich, Marchioninistr 15, 81377 Munich, Germany, E-mail: lukas_n@gmail.com*

Received: 04 January, 2023, Manuscript No. jnmrt-23-95755; **Editor assigned:** 06 January, 2023, PreQC No. P-95755; **Reviewed:** 19 January, 2023, QC No. Q-95755; **Revised:** 25 January, 2023, Manuscript No. R-95755; **Published:** 31 January, 2023, DOI: 10.37421/2155-9619.2023.14.525

et al.'s approach of using separate phantoms for PG and gafchromic film measurements, we used the same phantom for PG and IC inserts, which eliminates any potential disparities in phantom geometry. This also allowed us to normalize the relative 3D dose obtained with PG to the absolute IC reference dose, which is only possible with dedicated phantoms that have exchangeable inserts. Additionally, we improved dosimetric accuracy by using a $1 \times 1 \times 1$ mm^3 dose calculation grid.

Conclusion

In this study, we assessed the suitability of a novel hybrid anthropomorphic phantom for use with a 0.35 T MR-linac. We observed good agreement in the high dose region used for normalization, but noted a mean error of 0.2 Gy (5.6%) in the intermediate dose region (3.2 Gy-4.8 Gy) for normalization N1 (IC measured dose). The 3D printed anthropomorphic phantoms' modular design allowed us to normalize the R2-map to the IC absolute dose reference, resulting in a 3D dose map that enabled us to analyze the dose distribution extensively, including organ at risk (OAR) and planning target volume (PTV) dose volume histograms (DVH). We evaluated the dosimetric and spatial accuracy of the MR-linac system for three similar cases in the cranial region. To validate the reproducibility and stability of PG dose measurements, we repeated measurements on each phantom using PG from different production batches and readout on two separate 1.5 T diagnostic MR scanners. This also helped to manage scanning times. Overall, we found high spatial accuracy for complex, non-adapted cases, but small setup deviations could potentially compromise the DVH of OARs close to or within steep dose gradients. None.

Acknowledgment

None.

Conflict of Interest

None.

References

1. Brezovich, Ivan A., Xingen Wu, Richard A Popple and Elizabeth Covington, et al. "Stereotactic radiosurgery with MLC-defined arcs: Verification of dosimetry, spatial accuracy and end-to-end tests." *J Appl Clin Med Phy* 20 (2019): 84-98.
2. Molinelli, S1, A Mairani, A Mirandola and G Vilches Freixas, et al. "Dosimetric accuracy assessment of a treatment plan verification system for scanned proton beam radiotherapy: One-year experimental results and Monte Carlo analysis of the involved uncertainties." *Phy Med Biol* 58 (2013): 3837.
3. Paradis, Eric, Yue Cao, Theodore S Lawrence and Christina Tsien, et al. "Assessing the dosimetric accuracy of magnetic resonance-generated synthetic CT images for focal brain VMAT radiation therapy." *Int J Rad Oncol Biol Phy* 93 (2015): 1154-1161.
4. Gustafsson, C., Fredrik Nordström, E Persson and Johan Brynolfsson, et al. "Assessment of dosimetric impact of system specific geometric distortion in an MRI only based radiotherapy workflow for prostate." *Phy Med Biol* 62 (2017): 2976.
5. Low, Daniel A., Sasa Mutic, James F Dempsey and Russell L Gerber, et al. "Quantitative dosimetric verification of an IMRT planning and delivery system." *Radiother Oncol* 49 (1998): 305-316.
6. Brady, Samuel, Terry Yoshizumi, Greta Toncheva and Donald Frush. "Implementation of radiochromic film dosimetry protocol for volumetric dose assessments to various organs during diagnostic CT procedures." Med Phy 37 (2010): 4782-4792.

How to cite this article: Nierer, Lukas. "Assessment of Spatial and Dosimetric Accuracy of a 0.35 T MR-Linac Using a Modular Phantom and PG Measurements." *J Nucl Med Radiat Ther* 14 (2023): 525.