Rural Research Capacity Building Program (RRCBP)

Research Report

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An anthropomorphic 3D printed inhomogeneity thorax phantom slab for SBRT commissioning and quality assurance

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Stephen How is a radiation oncology medical physicist based in Orange, Western NSW LHD who graduated from the ACPSEM TEAP program in Feb 2023. As a 2019 RRCBP candidate, he completed his research on anthropomorphic 3D printed phantoms for stereotactic body radiotherapy (SBRT) commissioning and quality assurance.

Stephen is committed to ensuring that cancer patients receive accurate and precise radiation therapy, minimising their side effects and improving their overall quality of life. He remains dedicated towards continually implementing improved clinical work practices for the safe and efficient turn-around of radiotherapy patient care.

Stephen is passionate about sharing his knowledge and contributing to further advancements within the wider medical physics community.

Background

Anthropomorphic phantoms with tissue equivalency are required in radiotherapy for quality assurance of imaging and dosimetric processes used in radiotherapy treatments. Commercial phantoms are expensive and provide limited approximation to patient geometry and tissue equivalency.

Methods

In this study, a 5 cm thick anthropomorphic thoracic slab phantom was designed and 3D printed using models exported from a CT dataset to demonstrate the feasibility of manufacturing anthropomorphic 3D printed phantoms onsite in a clinical radiotherapy department.

The 3D printed phantom was manufactured with polylactic acid with an in-fill density of 80% to simulate tissue density and 26% to simulate lung density. A common radio-opacifier, barium sulfate (BaSO4), was added 6% w/w to an epoxy resin mixture to simulate similar HU numbers for bone equivalency. A half-cylindrical shape was cropped away from the spine region to allow insertion of the bone equivalent mixture. Two Gafchromic™ EBT3 film strips were inserted into the 3D printed phantom to measure the delivery of two stereotactic radiotherapy plans targeting lung and bone lesions respectively.

Results

Results were analysed within SNC Patient with a low dose threshold of 10% and a gamma criterion of 3%/2 mm and 5%/1 mm. The resulting gamma pass rate across both criterions for lung and bone were ≥ 95% and approximately 85% respectively.

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Conclusion

Results shows that a cost-effective anthropomorphic 3D printed phantom with realistic heterogeneity simulation can be fabricated in departments with access a suitable 3D printer, which can be used for performing commissioning and quality assurance for stereotactic type radiotherapy to lesions in the presence of heterogeneity.

Keywords

3D printing; Commissioning; Inhomogeneity; Phantom; Quality assurance; SBRT.

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