SABR pre-treatment verification using multiple dosimeters (alanine, nanoDot, PTW60019, and TLD100H)

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INTRODUCTION

- Stereotactic Ablative Radiotherapy (SABR) remains one of the most preferred treatment techniques for early-stage bronchogenic carcinomas and can be extended to more treatment locales involving sternum and scapula as well as the spine,[1,2]. SABR uses small fields that mandate the use of miniature for pre-treatment checks.
- A pre-treatment verification plan is a significant step in complex radiation treatment procedures, ensuring that the planned dose is received by the patient while limiting excess dose to critical organs with healthy tissues. Recent advancements in radiation therapy have led to new treatment procedures that could achieve the goal with minimal efforts[3].

AIM

- To Perform SABR pre-treatment verification using multiple dosimeters (alanine, nanoDot, PTW60019, and TLD100H) for three treatment sites of spine, scapula, and sternum and compare with the Eclipse treatment planning system (TPS) dose calculation.

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METHOD

- Stereotactic ablative radiotherapy (SABR) pre-treatment verification was conducted for the multiple dosimeters after the assessment of its dose linearity, energy, directional, and dose rate dependence.
- Four different inserts were designed and fit into the in-house phantom (RodPhantom) to conduct SABR measurement for the spine, scapula, and sternum treatment site.
- Alanine signal intensity was read using Electron-paramagnetic resonance spectrometer (Bruker EleXsys E500) of 9.5 MHz, and Harshaw QS 5500 was used to read the TLDs. The charge response of microDiamond (PTW60019) and the signal intensity of the exposed nanoDot OSL were read using Dose 1 electrometer and Microstar Reader (Landauer Inc.) respectively.
- Eclipse Anisotropic Analytical Algorithm (AAA) was used for Patient plan calculation.

RESULTS

- A less significant influence was observed with all dosimeters for directional, dose-rate, and energy dependencies.
- For all the three treatment sites considered in this report, the data were performed in duplicate and expressed as mean ± SD of the measured and Eclipse treatment dose:
- Alanine dosimeter (19.59 ± 0.24, 17.98 ± 0.15, 17.95 ± 0.18),
- nanoDot OSLD (19.70 ± 0.43, 17.05 ± 0.08, 17.95 ± 0.98),
- microdiamond (19.69 ± 0.05, 17.76 ± 0.65, 17.68 ± 0.63): and
- TLD100H (19.65 ± 0.38, 18.06 ± 0.70, 17.97 ± 0.20) respectively for spine, scapula, and sternum.
- The percentage difference of the dosimeters was within 2%, except TLD100H, with a 3 % difference. In particular, alanine and nanoDot recorded a percentage difference < 2% .

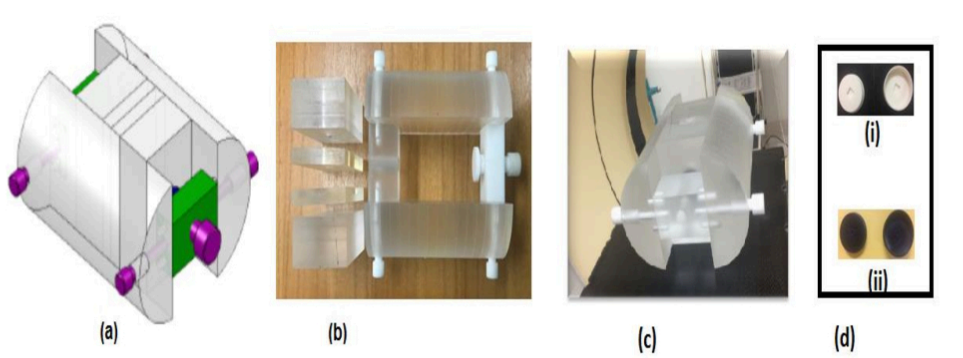

Fig. 1. Designed Rod phantom (b) Top view segment of rod phantom (c) Assembled rod phantom ready for CT scanning (d) (i) printed inserts of nanoDot, and (ii) printed insertion of alanine.

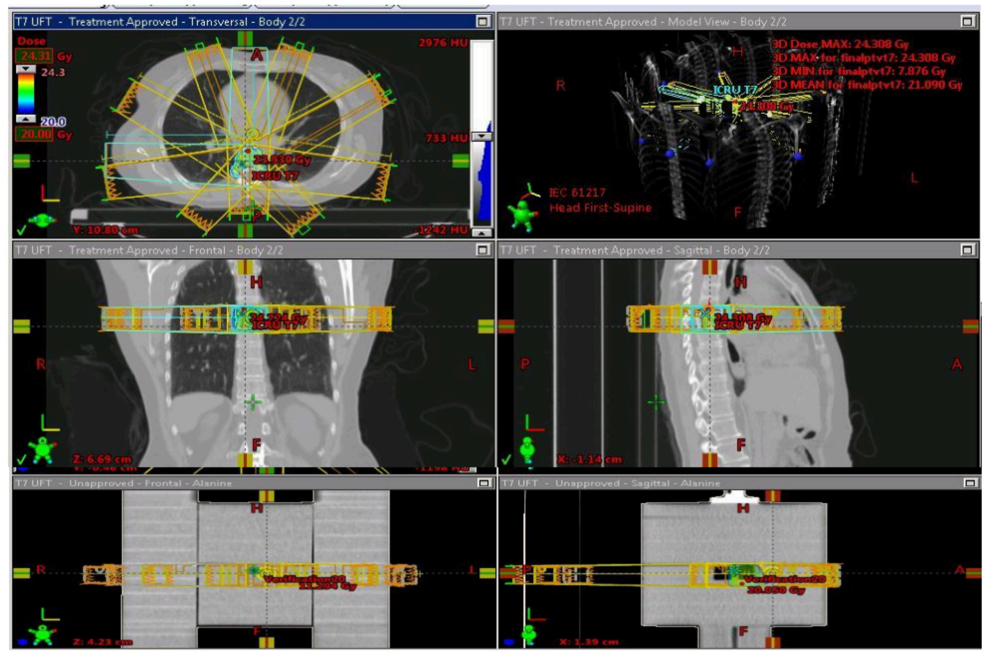

Fig. 2: T7 Vertebrae thoracic – Spine IMRT SABR based plan superimposed on the phantom

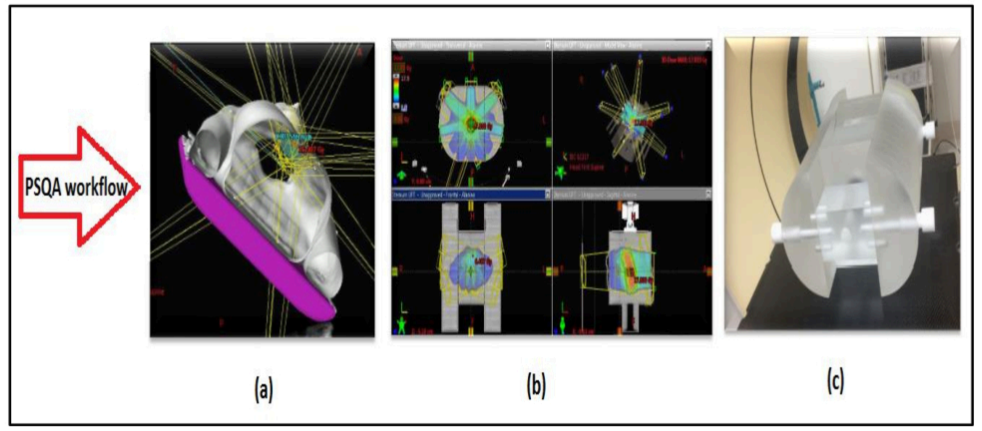

Fig. 3: Patient-specific quality assurance (PSQA) workflow (a) transversal view of UFT treatment (b) model, sagittal, frontal and model view of treatment sites (c) experimental set-up of the designed insert on a CT

CONCLUSIONS

- This result demonstrates that the dosimeters are reliable and give a high degree of consistency between the measured and Eclipse planned dose, and therefore prove to be useful dosimeters for patient SABR pre-treatment quality assurance.

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REFERENCES

Sharpe, P., & Sephton, J., 2000. An automated system for the measurement of alanine/EPR dosimeters. Applied Radiation and Isotopes, 52(5), 1185-1188.

Gall, K., Desrosiers, M., Bensen, D., & Serago, C. 1996. Alanine EPR dosimeter response in proton therapy beams. Applied Radiation and Isotopes, 47(11), 1197-1199.

Wagner, D., Anton, M., & Vorwerk, H., 2011. Dose uncertainty in radiotherapy of patients with head and neck cancer measured by in vivo ESR/alanine dosimetry using a mouthpiece. Physics in Medicine and Biology, 56(5), 1373-1383.

Nagy, V., & Desrosiers, M., 1996. Complex time dependence of the EPR signal of irradiated L-α-alanine. Applied Radiation and Isotopes, 47(8), 789-793.

Arber, J., & Sharpe, P., 1993. Fading characteristics of irradiated alanine pellets: The importance of pre-irradiation conditioning. Applied Radiation and Isotopes, 44(1-2), 19-22.

Sleptchonok, O., Nagy, V., & Desrosiers, M. 2000. Advancements in the accuracy of the alanine dosimetry system. Part 1. The effects of environmental humidity. Radiation Physics and Chemistry, 57(2), 115-133.

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