2024 Annual Meeting Abstracts – General Poster Discussion

MEDICAL PHYSICS

Science Program General Poster Discussion (Group B) Abstracts

TU300-GPD(B)-LOUNGE-162, Study of a New Formulation for a Phosphorus-32 Polymeric Source for Use in Brachytherapy: L. E. H. Teodoro*, C. F. Talacimon, A. C. K. D. S. Silva, A. L. Burin, I. M. M. A. Medeiros, M. E. Z. Rigo, P. S. Rodrigues, P. V. D. S. Tavares, S. S. Sgrignoli, L. V. Angelocci, J. M. Vieira, C. A. Zeituni and M. E. C. M. Rostelato, IPEN - Instituto de Pesquisas Energéticas e Nucleares, São Paulo, SP, Brazil

Purpose: To evaluate a new material for a phosphorus-32 polymeric film to use in brachytherapy for paraspinal and intracranial tumors and to analyze its activity distribution. **Methods:** As phosphorus-32 comes in the form of orthophosphoric acid, several tests were conducted to determine the best resin to encapsulate it. Initially, acid without radiation was used. Each test was repeated at least five times to ensure its result. Two variables were checked to evaluate the results: whether the resin cured or not, and if the final product was flexible. All tests were conducted with the selected resin being poured in molds of 5.0 x 5.0 x 0.04 cm. After selecting the considered suitable resins, acid with the active phosphorus-32 was used to produce the source. The film's activity was measured on an ionization chamber detector. After measuring the activity from the whole film, it was cut into pieces of 1.0 x 1.0 cm and then measured again to verify the activity's distribution. **Results:** From the resin tests, two of them stood out, for both their curing properties and malleability: silicone rubber with platinum catalyst and polyvinyl alcohol (PVA). Other resins evaluated whether did not cure or the film was considered not flexible. The activity measurements for the silicone rubber samples had a mean value of 227.92 ± 1.30 MBq (or 6.160 ± 0.005 mCi) and the distribution was acceptable. For the PVA, the activity mean value was 243.09 ± 1.39 MBq (or 6,573 ± 0.005 mCi) and the distribution was also acceptable. **Conclusion:** This work indicates a potential for a new flexible brachytherapy source, which could improve the surgical technique for central nervous system tumor resection and treatment. The activity results were promising according to the literature for a HDR source and further investigation on its dosimetry is needed to evaluate it.

TU300-GPD(B)-LOUNGE-163, Dose Verification and Monte Carlo Modeling of an Image-Guided Small Animal Radiotherapy Irradiator: J. D. Dominici*[1], T. Gutu[2] and C. Wang[1], (1)Duke University, Durham, NC, (2)Duke Health, Durham, NC

Purpose: To simulate and validate beam output of a Small Animal Radiotherapy Research Platform (SARRP, xStrahl) with both physical dosimetry and Monte Carlo simulation models. **Methods:** The SARRP console was set up to deliver an intended dose of 8Gy delivering a total of 8 Gy (4 Gy anterior-posterior (AP), 4 Gy posterior-anterior (PA)) in 142 seconds to a flat mouse phantom. The x-ray irradiation parameters were set to 13 mA, 220 kVp, with a 33.725 cm source to surface distance. Beam filtration included 0.8 mm Be (inherent) and 0.15 mm Cu (added), with collimation set to 40x30 mm. Dose verification was conducted through two methods: utilizing an energy-calibrated MOSFET dosimeter and employing Monte Carlo Simulations using Monte Carlo N- Particle Transport (MCNP). MOSFET Calibration encompassed four setups to ensure precision. The MCNP simulation comprised two stages: a point source simulation and a simulation of the x-ray tube. For the point source, the SARRP geometry was replicated, with the x-ray tube modeled as a collimated point source. The x-ray tube simulation entailed modeling components of the x-ray tube. Validation methods included comparing energy spectra and conducting Half Value Layer (HVL) testing. **Results:** Both verification methods showed good agreement with the intended 8 Gy irradiation. The MOSFET calibration showed agreement within 2.38%. Point Source Simulation showed agreement within 0.500%. X-ray Tube Simulation showed agreement within 1.25%. Energy spectrum of the MCNP model showed good agreement with the manufacturer model in key spectral characteristics (peaks, mean energies). HVL comparison showed good agreement with only a 0.500% difference between simulated and experimental half value thicknesses. **Conclusion:** The dose verification processes establish the SARRP's efficacy in delivering the intended radiation dose. The integration of advanced measurement techniques set a benchmark for small animal dosimetry and ultimately strengthens the reliability of radiation doses in preclinical studies.

TU300-GPD(B)-LOUNGE-164, Ethos Patient-Specific Quality Assurance Outcome Prediction Using Machine Learning: A. Witztum*[1], J. Hink[2], P. D. H. Wall[3], J. Neylon[4], T. D. Solberg[5], J. M. Lamb[2] and G. Valdes[1], (1)University of California San Francisco, San Francisco, CA, (2)University of California Los Angeles, Los Angeles, CA, (3)Washington University School of Medicine in St. Louis, St. Louis, MO, (4)Department of Radiation Oncology, University of California, Los Angeles, Los Angeles, CA, (5)University of Washington, Seattle, WA

Purpose: Ethos (Varian, Palo Alto, CA) is an advanced online adaptive radiotherapy (OART) system that generates treatment plans based on daily anatomical changes. Currently, pre-treatment patient-specific quality assurance (PSQA) relies solely on independent dose recalculation, which does not assess deliverability. We propose enhancing this process by developing machine learning (ML) models to predict gamma passing rates (GPR) for diode array measurements, thus refining PSQA without the need for beam delivery. **Methods:** A dataset of 206 Ethos treatment plans and associated PSQA outcomes was retrospectively collected at a single institution. PSQA measurements were performed using an Octavius (OTW, Freiburg, Germany) ion chamber array, analyzed with 3%/2mm global GPR criteria. The upper and lower MLC banks were virtually interleaved to a single bank and complexity features representing 30 different classes of failure modes were extracted from the DICOM RT-Plan file using in-house Python software (totaling 204 raw features). Gamma Regression (GR) and Random Forest (RF) ML models were built to predict GPRs using 10-fold cross-validation with the scikit-learn Python package. **Results:** GR and RF models have R-squared values of 0.24 and 0.22, Mean Absolute Error of 1.25 and 1.30, and 94% (84%) and 93% (80%) of plans with absolute prediction error <3% (<2%). To

