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Commissioning and Validation of a Monte Carlo Algorithm for Spine Stereotactic Radiosurgery

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MEDICAL PHYSICS

TU-I345-IePD-F4-04, Commissioning and Validation of a Monte Carlo Algorithm for Spine Stereotactic Radiosurgery: C Knill*, R Sandhu, B Loughery, L Lin, R Halford, D Drake, M Snyder, Beaumont Health, Royal Oak, MI

Purpose: A 6FFF Monte Carlo (MC) dose calculation algorithm was commissioned for spine stereotactic radiosurgery (SRS) planning on the Versa HD. Initial model generation, validation, and ensuing model tuning will be presented. **Methods:** The model was generated by the manufacturer, Brainlab, using both in-air and in-water commissioning measurements of field sizes between 6mm and 400mm on the Versa HD. Initial model validation was performed by simulating a water tank in the planning system, calculating commissioning fields, and comparing calculations to measured data. Model accuracy was quantified for output factors, PDDs, profile sizes, and profile penumbras. Nine previously treated Spine SRS patients were aggressively re-optimized with the new MC model to lower spinal cord dose through increased modulation. The resulting plans were calculated on the StereoPHAN phantom and subsequently delivered to the microDiamond and SRSMapcheck to verify calculated dose accuracy. Model tuning was performed by varying the model's light field offset (LO) distance between the physical and radiological positions of the collimating jaws and MLC, with goal of improving the accuracy of the field size and StereoPHAN calculations. **Results:** Calculated output factors were within 2% of measured for square field sizes down to 10mm. PDDs were within 2% of measured past dmax. Penumbra widths were within 1mm for the MLCs and 0.5mm for Jaws. Field sizes were within 0.5mm for both MLC and Jaws. On average, microdiamond measured point doses were within –1.01%+/-2.18% and 0.311%+/-1.20% for targets and OARs, respectively. Average per-plan pass rates using a 2%/2mm/10% threshold relative gamma analysis were 99.1%+/-0.89%. Adjusting LOs led to improved open field and patient-specific dosimetric agreement. **Conclusion:** Initial validation of a Monte Carlo algorithm for simple fields and complex SRS spine deliveries in homogeneous phantoms have been performed. Subsequent validation is needed in heterogeneous phantoms.

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Exhibit Hall | Forum 5: Multi-Disciplinary Interactive ePoster Discussion; Advancing Science to Expand Access to State-of-the-Art Applications in Medical Physics: III

TU-I345-IePD-F5-01, A Novel Lesion-Center-Based Machine Learning Pipeline for Distinguishing Between Metastatic and Healthy Bone Regions in Cancer Patients: H Naseri[1]*, S Skamene[2], M Tolba[2], M Faye[2], P Ramia[2], J Khriguian[2], H Patrick[2], A Andrade[3], M David[2], J Kildea[1]</sup>,(1) McGill University, Montreal, QC, CA, (2) McGill University Health Center, Montreal, QC, CA, (3) UT Southwestern Medical Center, Dallas, TX,

Purpose: To investigate the feasibility of building a fast and accurate radiomics-based machine learning (ML) pipeline for detecting spinal metastatic bone lesions in radiotherapy treatment (RT) planning-CT images of cancer patients using just geometric regions of interest (ROIs) centered on expert-identified lesion point locations without the need for full 3D ROI segmentation. **Methods:** Our dataset consisted of planning-CT images from 189 spinal bone metastasis (BM) patients and 170 non-metastatic lung cancer patients as controls. Instead of full 3D contouring, the point locations of 631 BM and 674 healthy bone (HB) regions were manually identified by experts. ROIs with various geometric shapes and sizes (spherical and cylindrical-along-z-axis) were centered and automatically delineated on the identified locations, and 107 radiomics features were extracted. The synthetic minority oversampling technique (SMOTE) was used for re-sampling (RS) and the least absolute shrinkage and selection operator (LASSO) technique was for feature selection (FS). We evaluated several machine learning (ML) classifiers using the area under the receiver operating characteristic curve (AUC) to obtain the best-performing model. **Results:** Per expert feedback, the point-based segmentation process is 10-15 times faster than a manual full 3D segmentation. Among ML classifiers, Gaussian process regression (GPR), neural network (NNet), and linear support vector machine (L-SVM) classifiers achieved higher performance compared to other classifiers. The AUC, precision, and recall of our best-performing classifier (GPR) were 97%, 0.92, and 0.91, respectively.In addition to its simplicity and ease of use, the performance of our pipeline was comparable to what was reported by prior studies using full 3D delineated ROIs. **Conclusion:** Our point-based ML pipeline successfully differentiated metastatic spinal bone lesions from healthy bones in planning-CT images. Our tool allows radiation oncologists to quickly identify point locations of BM images for use in radiomics-ML studies without the time-consuming bottleneck of full ROI segmentation.

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