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Comparison of treatment planning system algorithms and monte carlo simulations for oesophageal radiotherapy

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Purpose/Objective: Several articles have been published comparing the results of Monte Carlo (MC) simulations with treatment planning system calculations, both generally and on a site-specific basis e.g. for prostate, head and neck and lung treatments. However, limitations of the simulations published for oesophageal radiotherapy are rare, despite the fact that the treatment volume lies in a region of heterogeneous anatomy involving a number of organs at risk (e.g. spinal cord, heart, lung). The aim of this work is to develop an efficient framework for performing MC simulations of clinical oesophageal treatments, so that the results of a statistically significant number of clinical cases may be compared in order to evaluate the differences between planning algorithms robustly as possible.

Materials and Methods: Radial oesophageal radiotherapy plans are now routinely produced in our centre according to a protocol originally developed for the UK national SCOPe trial. Plans were performed using the Pencil Beam Enhanced (PBE) and Collapsed Cone Enhancement (CCE) algorithms within Nuclotron Oncentra MasterPlan (OMP v3.3 Service Pack 1). The DICOM CT, Structure Set, Plan and Dose files are exported from OMP for clinical plans. Python scripts were used to anonymise the data, remove any private DICOM tags, and alter Region Of Interest (ROIs) to follow a specific naming convention. The anonymised DICOM files were uploaded to our RTGrid calculation platform, a system that creates MC input files from DICOM files and allows MC simulations to be performed on distributed computing resources at Cardiff University, with the results from different computers being automatically combined by the RTGrid system. The RTGrid platform has recently been adapted to handle CT scans involving iodine-based contrast agents and the Enhanced Dynamic Wedge (EDW) for Varian Linear Accelerators (linacs). After simulation, the dose matrices produced by RTGrid were converted from energy deposited per photon to Gray, following the method of Liu to account for backscatter to the monitor chamber of the linac. The 3D dose matrices were then converted to DicomRT-DOSE files, following the method of Tekel. The output distributions can either be imported back into OMP or, using scripts written in Matlab, in to CERR, for calculation of Dose Volume Histograms (DVHs) and other plan metrics.

Results: Initial results from the study to date indicate that the dose to 95% of the Planning Target Volume (PTV) varies by up to 5%, with similar levels of difference in Organ at Risk (OAR) doses.

Conclusions: A system has been developed to perform MC simulations of Oesophageal treatment plans with minimal user interaction. Initial investigations indicate that DVH parameters used in the reporting of Oesophageal treatment plans with minimal user interaction. Initial investigations indicate that DVH parameters used in the reporting of Oesophageal treatment plans with minimal user interaction. Initial investigations indicate that DVH parameters used in the reporting of Oesophageal treatment plans with minimal user interaction. Initial investigations indicate that DVH parameters used in the reporting of Oesophageal treatment plans with minimal user interaction.