Development of dysphagia optimised IMRT for head and neck cancer treatment in the DARS trial

Justine Tyler1, David Bernstein1, Keith Rooney4, Chris Nutting1.
1Royal Marsden NHS Foundation Trust, London, United Kingdom.
2Belfast Health and Social Care Trust, Belfast, United Kingdom.

Objective
To develop a dysphagia optimised IMRT (Do-IMRT) technique comparing fixed-field IMRT with VMAT for treatment of head and neck cancer in DARS (CRUK/14/014); a phase III randomised multicentre clinical trial of Do-IMRT versus standard IMRT (S-IMRT).

Method
Nine oropharynx cases were outlined and planned according to the DARS trial QA guidelines. CTVs were outlined using a volumetric approach with a 10mm GTV-CTV expansion. Pharyngeal constrictor muscles (PCM) were also delineated. The dose levels prescribed were 65 Gy to the primary site and involved nodes and 54 Gy to the elective volume in 30 fractions. Plans were produced according to the technique (Do-IMRT and S-IMRT) to be used in each treatment group of the trial using both fixed-field IMRT and VMAT (RapidArc®) with a Varian Eclipse™ treatment planning system (version 11). For Do-IMRT, the aim was to achieve a mean dose of less than 50 Gy to the superior and middle PCMs, excluding the CTV receiving 65 Gy (PlanSMPCM), and less than 20 Gy to the similarly edited inferior PCM (PlanIPCM). These constraints were prioritised over coverage of the PTV receiving 54 Gy (PTV_5400) but not the PTV receiving 65 Gy (PTV_6500). For S-IMRT no attempt was made to reduce PCM doses. Plans were assessed for their clinical acceptability and DVH statistics were compared.

Results
Using fixed-field IMRT for Do-IMRT, it was not possible to adhere to PCM constraints whilst achieving clinically acceptable plans in terms of either PTV_5400 coverage or homogeneity, as determined by clinicians experienced in treating head and neck cancer. However, using VMAT for Do-IMRT a PlanSMPCM mean dose of less than 50Gy was achieved in all cases, reduced significantly by 7.6Gy (95% CI 6.3 to 8.9) on average compared to S-IMRT. PlanIPCM mean doses of less than 20Gy were achieved in five cases, reduced significantly by 28.3Gy (95% CI 25.8 to 30.8) on average compared to S-IMRT. Do-IMRT plans had decreased but acceptable dose homogeneity and coverage was maintained, only compromising in the region where PCMs and PTV_5400 overlap (example shown in figure 1). A non-statistically significant increase in spinal cord and brainstem PRV doses was seen, but constraints were achieved in all cases. Contralateral parotid mean doses were increased by 2Gy on average. The increase in ipsilateral parotid mean doses was not statistically significant. The results are summarised in table 1.

Conclusions
Fixed-field IMRT may be used to reduce constrictor dose using Do-IMRT, however VMAT is more likely to produce plans acceptable within the DARS trial QA guidelines. A comprehensive QA programme will be implemented to ensure adherence to the guidelines and plan quality.

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Table 1: Comparison of VMAT Do-IMRT vs. S-IMRT plan dose-volume statistics for PlanPTVs (edited 5mm from body surface and excluding PlanPTV_5400 from PlanPTV_5400), spinal cord, brainstem, contralateral (CL) and ipsilateral (IL) parotids, PlanSMPCM and PlanIPCM.