

# Inter-fraction robustness of intensity-modulated proton therapy in the post-operative treatment of oropharyngeal and oral cavity squamous cell carcinoma

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## Purpose

To evaluate dosimetric consequences of inter-fraction set up variation and anatomical changes in patients receiving multi-field optimised (MFO) intensity modulated proton therapy for post-operative oropharyngeal and oral cavity cancers.

## Methods

Six patients treated with proton beam therapy for postoperative oropharyngeal and oral cavity cancer were evaluated. Plans were optimised to clinical target volumes (CTVs) with parameters of 3 mm setup and 3.5% range uncertainty. Each patient underwent weekly online cone-beam computed tomography (CBCT). Planning CT was deformed to the CBCT to create virtual CTs (vCTs) on which the planned dose was recalculated. vCT plan robustness evaluation was evaluated using a set up uncertainty of 1.5 mm and range uncertainty of 3.5%. Target coverage,  $D_{95\%}$ , and hotspots  $D_{0.03cc}$ , were evaluated for each uncertainty along with the nominal, error-free, plan. Mean dose to organs at risk (OAR) for the nominal plan and relative % change in weight from baseline were evaluated.

## Results

Robustly optimized plans in post-operative oropharyngeal and oral cavity patients using a single CT scan are robust against inter-fraction set up variations and range uncertainty. Max  $D_{0.03cc}$  in the nominal plans were clinically acceptable across all plans. No patients lost  $\geq 10\%$  weight from baseline, Figures 1a, 1b. Mean dose to the ipsilateral parotid gland, oral cavity, larynx, pharyngeal constrictor muscles and max dose to the spinal cord remained within tolerance, see figure 2.

Figure 1a

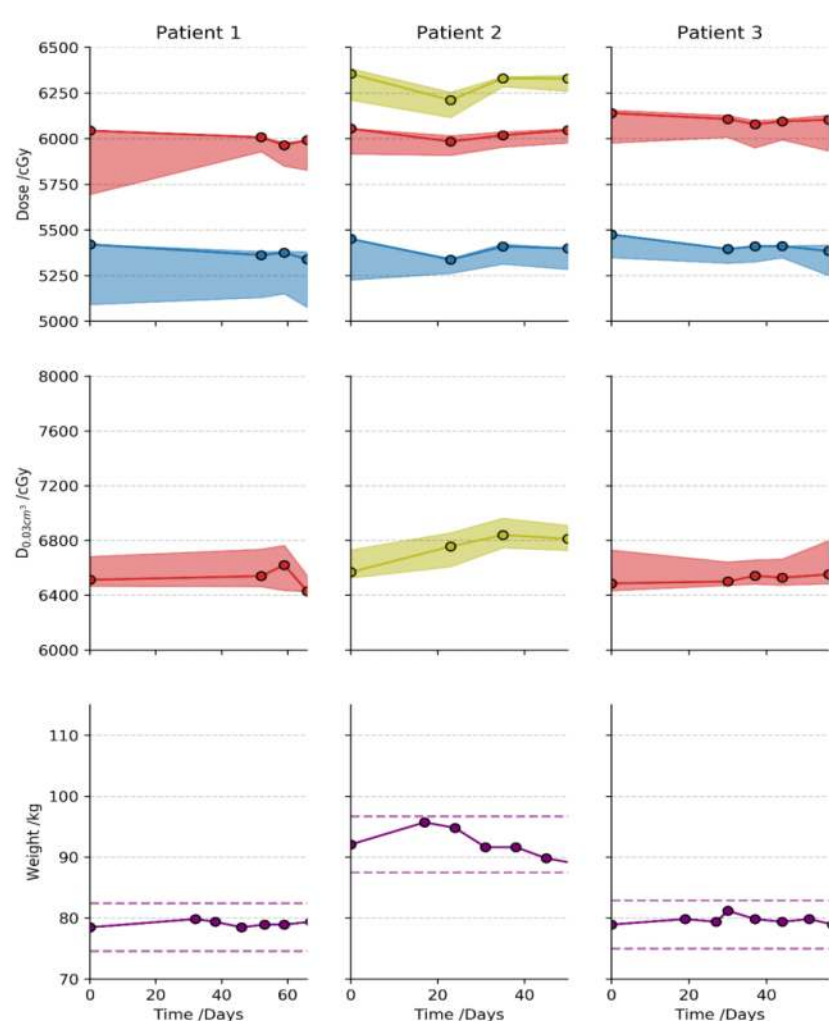


Figure 1b

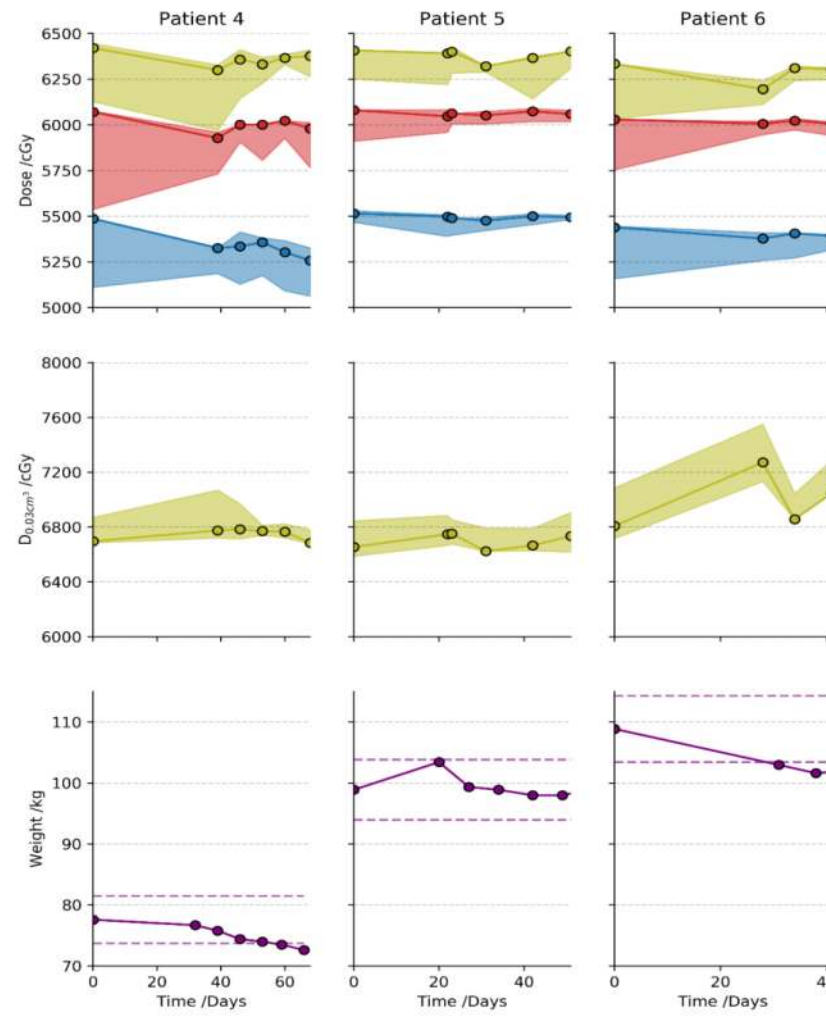
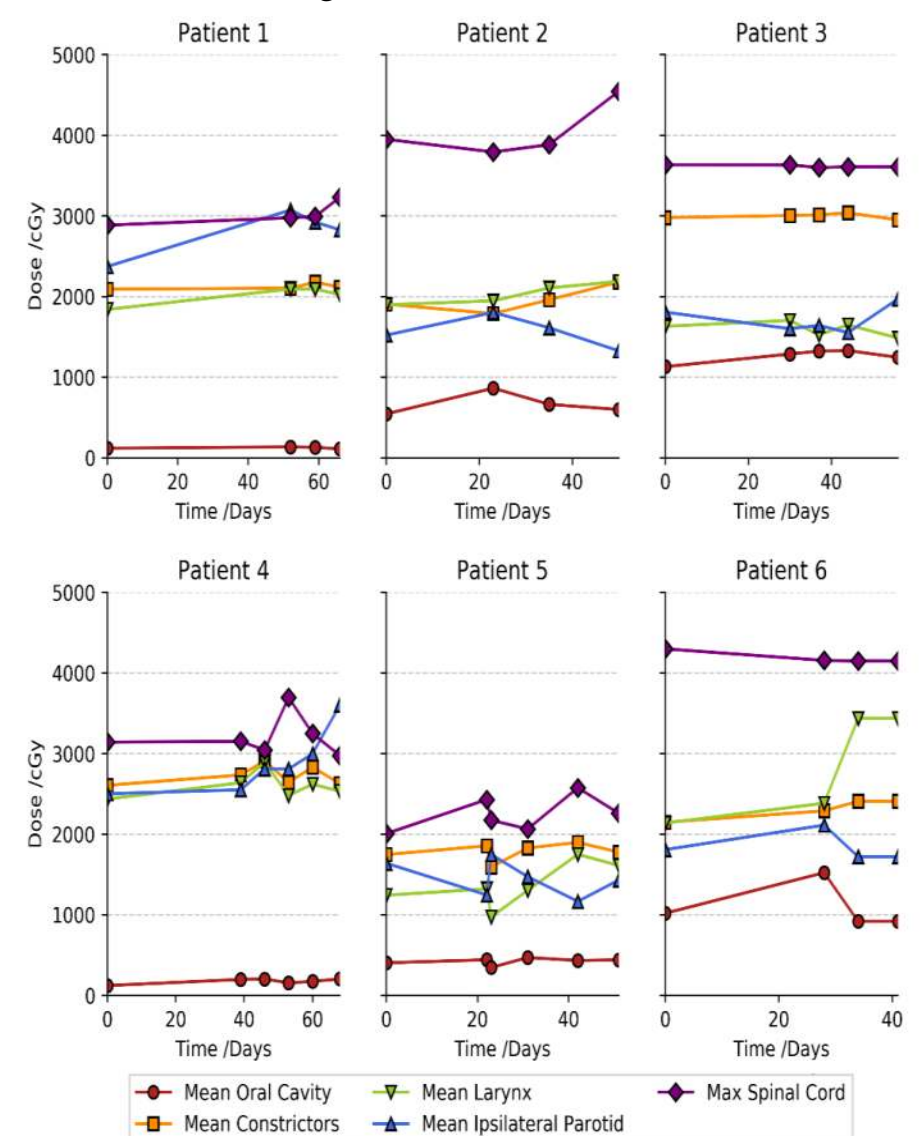


Figure 2



Figures 1a and 1b show an overview of the change in  $D_{95\%}$ ,  $D_{0.03cc}$  in the high risk CTV and patient weight over time. Uncertainties over all error scenarios are shown as a light band. CTV 63 (green), CTV 60 (red), CTV 54 (blue). The solid line shows the nominal dose. Dashed lines indicate weight changes of  $\pm 5\%$  from the baseline weight recorded at the time of the planning scan.

Figure 2 illustrates the changes in mean dose to the ipsilateral parotid gland, oral cavity, pharyngeal constrictor muscles, larynx and maximum dose to the spinal cord with time.

## Conclusion

MFO plans in post-operative oropharyngeal and oral cavity patients were robust to inter-fraction uncertainties in set up and range in regard to CTV coverage. A robust analysis protocol for MFO plans will improve consistent reporting and plan evaluation amongst radiotherapy centres.