# Editors' pick

# Evaluation of robustly optimised, intensity-modulated proton therapy for nasopharyngeal carcinoma

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*Radiotherapy and Oncology 168 (2022) 221–228. https://doi.org/10.1016/j.radonc.2022.01.043*

## *What was your motivation for initiating this study?*

Proton therapy (PT), and in particular intensity-modulated PT (IMPT), has the potential to improve the conformity of the dose distribution and to reduce doses to surrounding organs when compared with conventional photon treatments. This is important in the treatment of head and neck (HN) cancer, because many organs that are important contributors to the patient's quality of life are in close proximity to the treatment sites. IMPT also has the potential to be more sensitive to errors and therefore dose distributions may be significantly affected by patient misalignment or changing anatomy. This is important in HN cancer due to the prevalence of weight change, tumour response to treatment or variations in cavity filling, for example. This is especially important in the treatment of nasopharyngeal carcinoma (NPC), since organs with vital functions, such as the optic system, the brainstem and the brain itself, can receive high doses that are associated with potentially life-altering toxicities.

The technology of proton therapy treatment planning and delivery has evolved rapidly in recent years, including the widespread adoption of scanned proton beams and robust planning concepts. Coupled with the relatively rare incidence of NPC, there was an absence of published literature in this space. We therefore wanted to share our experiences using robustly optimised IMPT in NPC, with specific emphasis on the sensitivity of the dose distribution over the treatment course.

## *What were the main challenges during the work?*

We wanted to include as many patients as possible in our cohort in order to provide sound statistics over a diverse population and to give a realistic impression of the results in our clinic. When the study was initiated, 25 NPC patients had finished treatment, so we included them all. Each patient had seven weekly repeat CT scans and manual alteration of several regions of interest (ROIs) was performed for each rCT, which required an enormous time contribution from our clinicians and dosimetrist. Logistically, the amount of data that was generated by the multiple rCT dose distributions, deformable registrations, dose accumulations and ROI dose-volume histogram (DVH) statistics was impressive.

Additionally, there is considerable debate about the applicability of deformable image registration for dose warping and accumulation purposes in radiotherapy. There is, however, no better alternative if one wishes to estimate the actual given dose to the patient. To compensate for this, we included key ROI DVH statistics for every rCT of each patient in the supplementary materials section of our paper.

## *What is the most important finding of your study?*

There were a number of key results and the most important finding is perhaps different for each reader. Personally, it was reassuring to see that the dose distribution in the nasopharynx region was very robust and that maximum doses that were given to critical serial organs were similar to the planned values. Other key findings included the low rate of adaptation that was found to be necessary, the relationship between weight loss and increased normal tissue complication probability (NTCP), and that

substantial weight gain resulted in only mild target-coverage loss in the neck region. Readers may also be interested in the description of our planning approach and use of voxel-wise robust evaluation.

## *What are the implications of this research?*

This study adds to the growing body of evidence that robustly optimised IMPT is a promising treatment option in NPC. As access to PT ramps up worldwide, more NPC patients could benefit from the application of IMPT.

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