

Exploiting additional degrees of freedom in next generation radiotherapy treatment of Nasopharyngeal cancers: can a hybrid planning approach be superior?

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Background and aims

Modulated radiotherapy has enhanced the effectiveness of Nasopharyngeal cancer (NPC), treatment, achieving improved tumour coverage while sculpting doses around organs at risk (OAR). However, current optimisation algorithms might fall short in exploiting all the degrees of freedom of modern linear accelerators. A novel optimisation algorithm within Varian Eclipse treatment planning system uniquely leverages dynamic collimation and combines Volumetric Modulated Arc Therapy (VMAT) with the modulation of IMRT-like static angle modulated ports (STAMPs) in a single continuous delivery (RapidArc Dynamic-RAD). This study compares dosimetric and outcome parameters of RAD optimised plans versus conventional VMAT.

Material and Methods

A cohort of twenty T3-4, any N, M0 NPC patients treated at a single institution with 70Gy in 35 fractions (2019-2023) were re-planned with two RAD solutions with fully optimised collimator:

- 1) Single arc with 5 STAMPs- RAD1
- 2) 2 arcs with 4 STAMPs per arc- RAD2

RAD optimisation, blinded from VMAT, aimed to adhere to maximum clinical goals whilst prioritising target coverage and serial organs over parallel organs. Plan quality was assessed by comparing target coverage, OAR dose, Tumour Control and Normal Tissue Complication probability differences with VMAT (TCP/NTCP Deltas). TCP was calculated with the Marsden model¹ ($\alpha=0.3\text{Gy}^{-1}$, $\sigma_\alpha=0.09$, $\alpha/\beta=10\text{Gy}$) and NTCP for Xerostomia, Dysphagia and Mucositis were calculated with LKB², Multivariate Logistic regression³ and Logistic regression⁴ models, respectively. Wilcoxon signed-rank test was used ($p=0.05$).

Results

Compared to VMAT, mean GTV and PTV coverage (D98%) increased in RAD1 and RAD2 plans by 0.82Gy, $p=0.01$ and 0.87Gy, $p=0.01$, and 0.42Gy, $p=0.14$ and 0.71Gy, $p=0.01$ respectively. Mean OAR doses, TCP and NTCP were either equivalent or superior to VMAT (Fig. 1a-c).

Conclusions

The new delivery solution with added degrees of freedom can reduce doses to OARs while maintaining or improving target coverage promoting TCP increase and NTCP reduction for NPC.

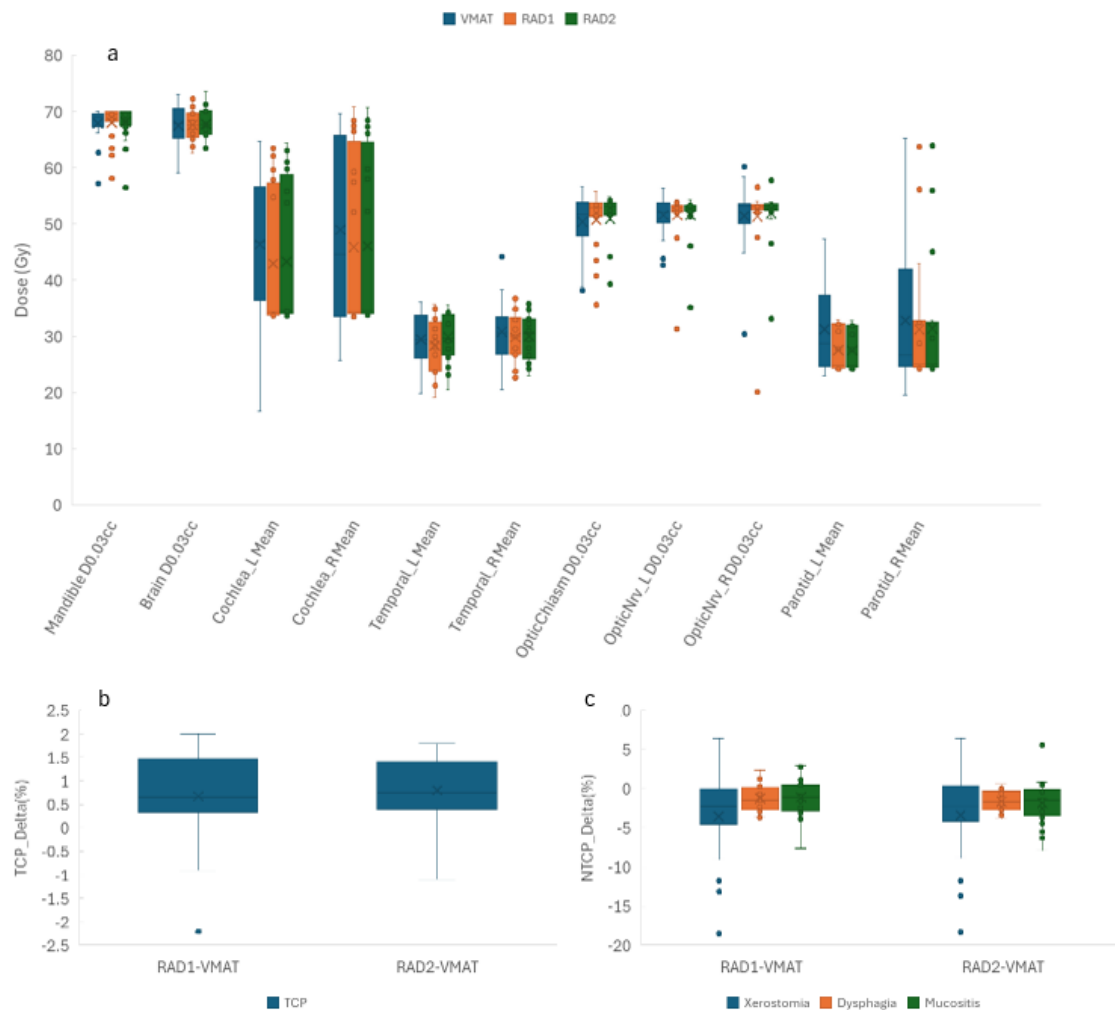


Figure 1: OAR dose metrics in Gy for VMAT (blue), RAD1(orange) and RAD2 (green)(a), TCP and NTCP for RAD1-VMAT and RAD2-VMAT (%) (differences here defined as Delta).

References

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