



# Dosimetric Advantages of Intensity Modulated Proton Therapy(IMPT) over Volumetric Modulated Arc Therapy(VMAT) for Locally Advanced Nasopharyngeal Cancer

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**Purpose:** To perform a dosimetric comparison of Intensity Modulated Proton Therapy (IMPT) and Volumetric Modulated Arc Therapy (VMAT) in locally advanced nasopharyngeal cancer(NPC) with regards to target volume coverage and sparing of organs at risk (OARs).

**Material and Methods:** Following Centralised Institutional Review Board (CIRB) approval, a total of eight patients with T3-T4Nx (AJCC, 7th ed.) Nasopharyngeal Cancer (NPC) with no evidence of distant metastasis were included in this study. The plans were prescribed with Simultaneous Integrated Boost (SIB) dose levels at 70Gy and 60Gy in 33 fractions to primary target volume and high risk subclinical region. For lower risk subclinical neck nodes, a prescription of 54-56Gy was given. IMPT and VMAT plans were generated for each patient using the same dose-volume constraints. IMPT plans were planned with a 5-Fielder multi-field optimization (MFO) technique using robust optimization (Fig 1). VMAT plans were planned with 3Arc fields (Fig 2). All plans were generated using Eclipse Treatment Planning System (V13, Varian Medical Systems Inc., Palo Alto, CA). The paired t test was used for all statistical comparison.

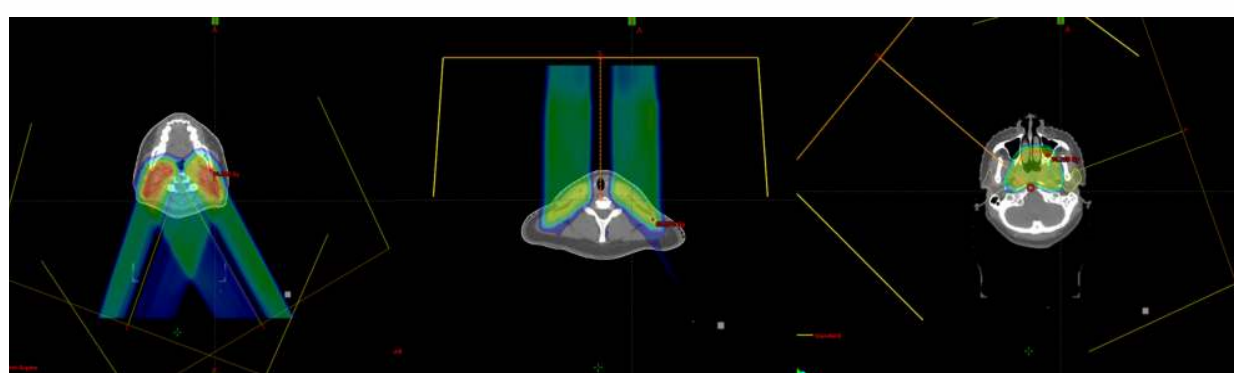


Fig 1: A 5F IMPT fields arrangement; Left: 2 Posterior oblique fields treating Superior Volume (at 20Gy colour wash); Middle: Single anterior for Inferior Volume (at 20Gy colour wash); Right: 2 Ant oblique fields to for additional boost to primary volumes (at 60Gy colour wash);

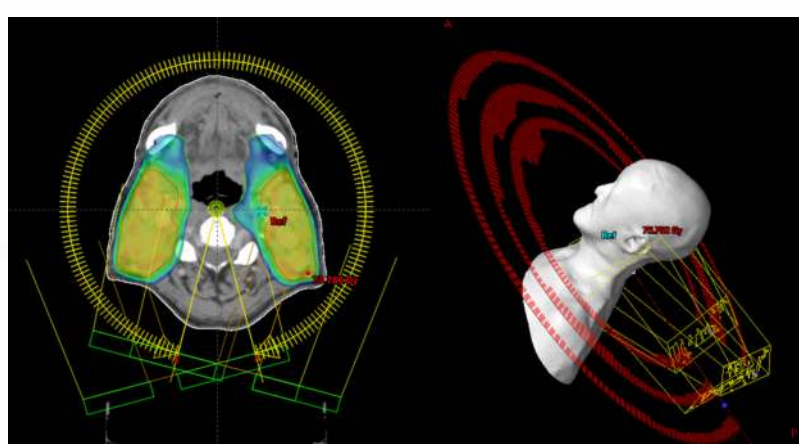


Fig 2: A 3F VMAT fields arrangement; Left: Axial slices indicating 3 full arc plans (at 60Gy colour wash); Right: Model view shows 3 Fields arc around target

**Results:** Both VMAT and IMPT planning techniques produced dosimetrically acceptable plans, with comparable clinical target volume (CTV) coverage and OARs dose that are within tolerance. Dose to 95% (D95) of CTV volumes were covered by 100% of prescribed dose in nominal plan for IMPT plans. In plan

uncertainty analysis (setup error: 3mm and range error: 3%), D95 of the CTVs received 95% of the prescribed dose for all IMPT plans in worst case scenarios. Dose reductions of more than 10Gy were observed with IMPT for parotid glands and oral cavity ( $p < 0.05$  for both). The D50 and mean doses in the left parotid glands, right parotid glands and oral cavity were significantly lower for IMPT (10.55Gy, 22.10Gy, 21.08Gy, 26Gy and 9.69Gy respectively) than VMAT plans (28.10Gy, 34.97Gy, 33.82Gy, 37.17Gy and 40.12Gy respectively). The dose comparison using bar chart and distribution in colour wash are shown below (Fig 3,4 )

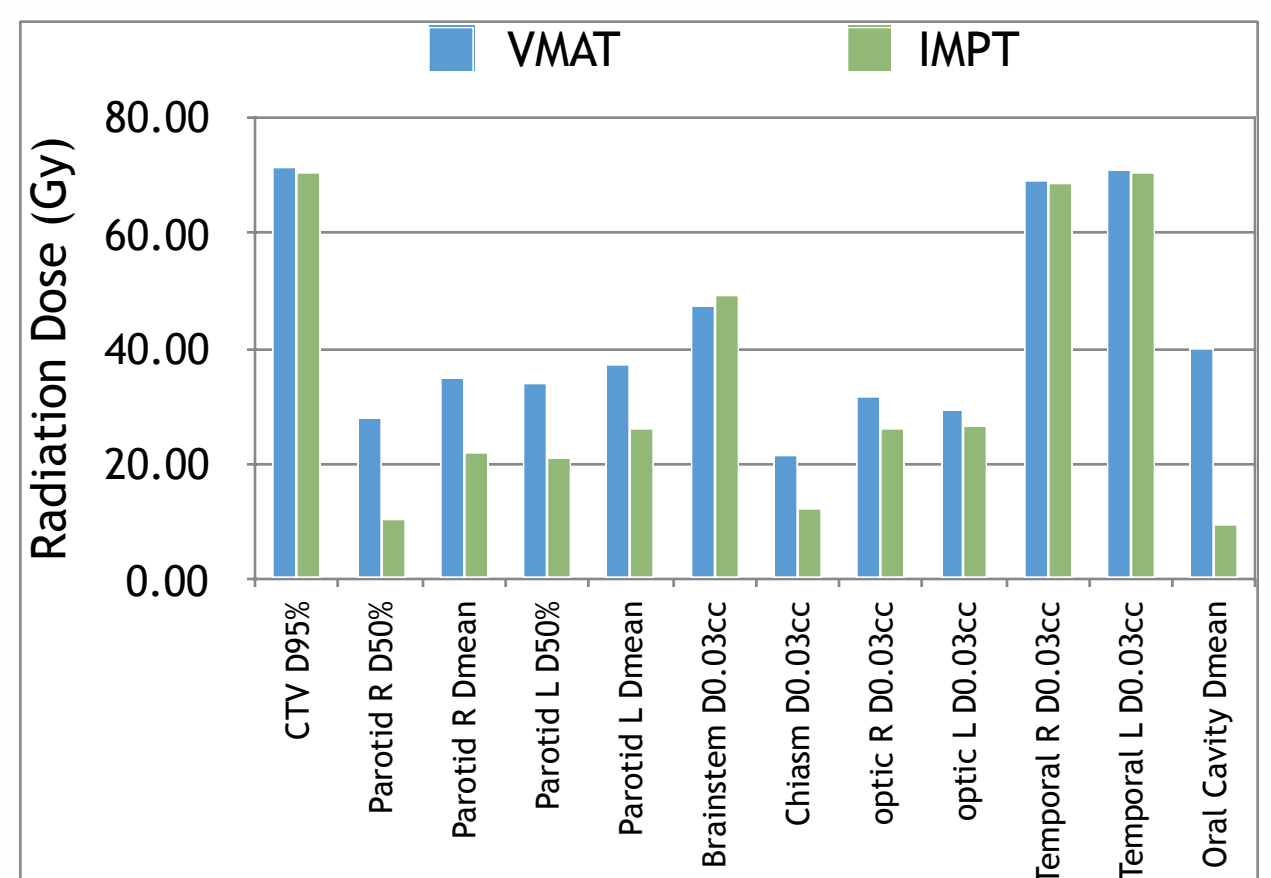


Fig 3: The comparison of dose coverage for CTV and some OARs between VMAT and IMPT plans

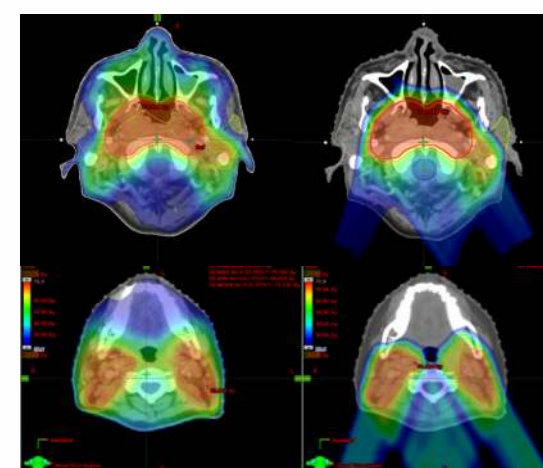


Fig 4: Indicate dose comparison between VMAT and IMPT plans at colour wash of 20Gy

Upper Left: VMAT plan at parotid  
Upper Right: IMPT plan at parotid  
Lower Left: VMAT plan at oral cavity  
Lower Right: IMPT plan at oral cavity

**Conclusion:** IMPT is a potential treatment option to reduce treatment toxicities especially xerostomia in NPC patients. However further studies are needed to determine if the dosimetric advantages conferred by IMPT translate to improvement in clinical outcome.

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