

Thyroid sparing volume modulated arc therapy in patients with non-distant metastatic nasopharyngeal carcinoma: a feasibility study

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INTRODUCTION & AIM

- ◆ Radiotherapy planning for nasopharyngeal cancer routinely requires the inclusion of bilateral cervical lymph node drainage areas in the target volume. The thyroid gland will inevitably be irradiated during therapy because it is located in the anterior neck.
- ◆ 40% -50% of patients receiving neck radiation therapy experience hypothyroidism¹. More and more studies have shown that radiation induced hypothyroidism follows a dose-dependent pattern²⁻⁵.
- ◆ **Aim: To evaluate the dosimetric feasibility of thyroid sparing volume modulated arc therapy (TS VMAT) in non-distant metastatic nasopharyngeal carcinoma patients.**

METHOD

- ◆ **Patients:** of the 30 patients diagnosed with non-distant metastatic nasopharyngeal carcinoma at the cancer hospital of Shantou university medical college between years 2020 and 2023, 10 received bilateral upper and lower neck irradiation (bilateral UNI group), 10 received bilateral lower neck irradiation (bilateral LNI group), 10 received one-side lower neck irradiation (one-side LNI group).
- ◆ **VMAT planning:** A TS VMAT plan and a non-thyroid-sparing volume modulated arc therapy (NTS VMAT) plan were designed for each patient according to Guidelines of Chinese Society of Clinical Oncology (CSCO, version 2023) and the Chinese Guidelines for Radiation Therapy of Nasopharyngeal Carcinoma (version 2022).
- ◆ **Plan evaluation:** Using dose volume histogram (DVH), homogeneity index (HI) and conformity index (CI) of all planning target volumes (PTVs), and irradiation doses to the thyroid and organs at risk (OARs) to assess the treatment plans. The attainment of TS VMAT plans was determined by ensuring that the thyroid Dmean did not exceed 45 Gy and the thyroid V40 did not exceed 85%.
- ◆ **Statistical analysis:** Paired t-test and Wilcoxon rank-sum test.

RESULTS

- ◆ **Target coverage, conformity and dose homogeneity**
- ◆ HI and CI were analyzed using the paired-sample T-test. We found that all of the TS VMAT plans and NTS VMAT plans were clinically acceptable.

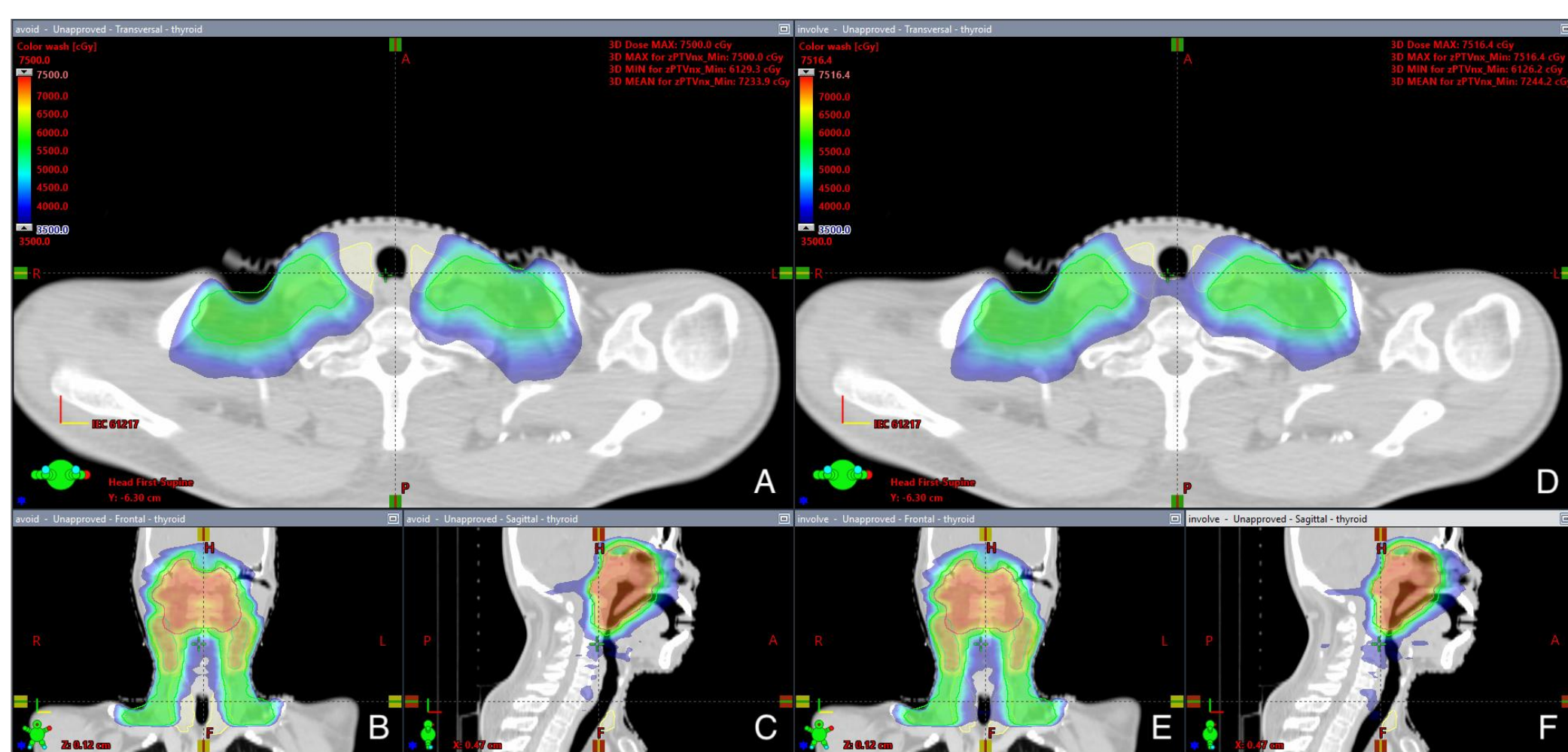


Fig. 1 Dose distributions on three axial views of one nasopharyngeal carcinoma case in the bilateral LNI group for NTS VMAT plans (A, B, C) and TS VMAT plans (D, E, F).

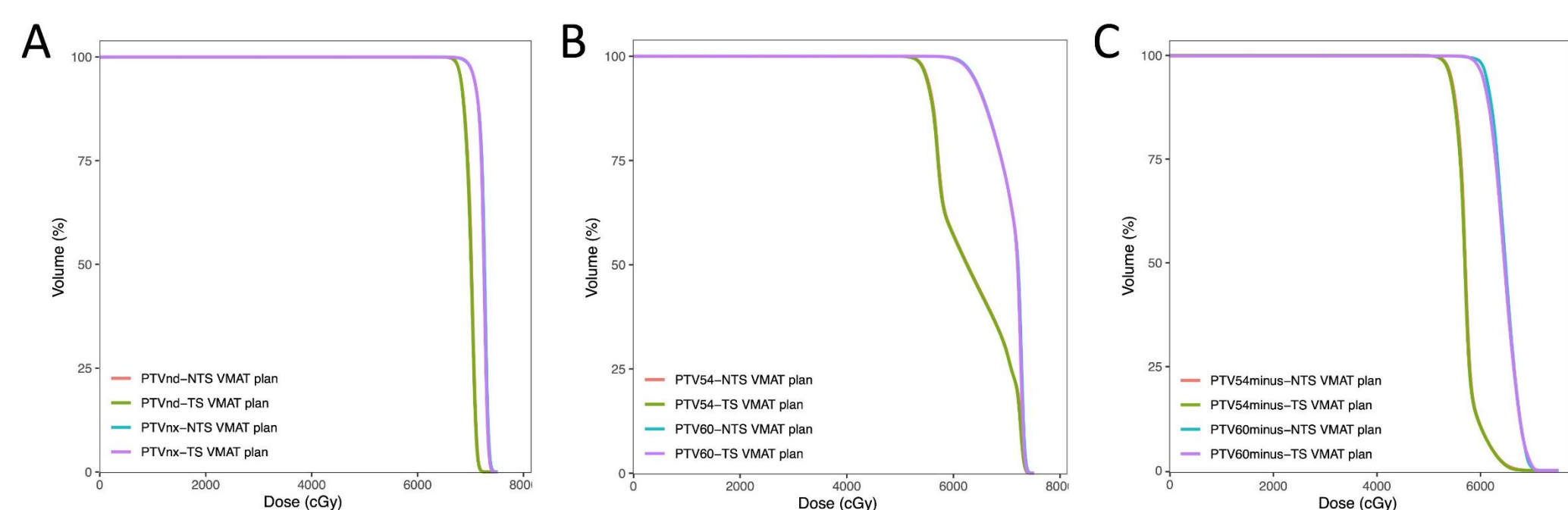


Fig.2 DVHs comparison of all PTVs for TS-VMAT and NTS VMAT plans of one nasopharyngeal carcinoma case in bilateral LNI group

RESULTS

◆ OARs

- ◆ We next discovered that in the TS VMAT plans for all groups, the radiation dosages to other OARs did not exceed clinical limits. Though there was a slightly elevated spinal cord irradiation dose (Gy) in TS VMAT plans compared with NTS VMAT plans (39.79 ± 2.66 vs 39.12 ± 2.30 , $p=0.028^*$) in the bilateral LNI group, this was clinically acceptable.

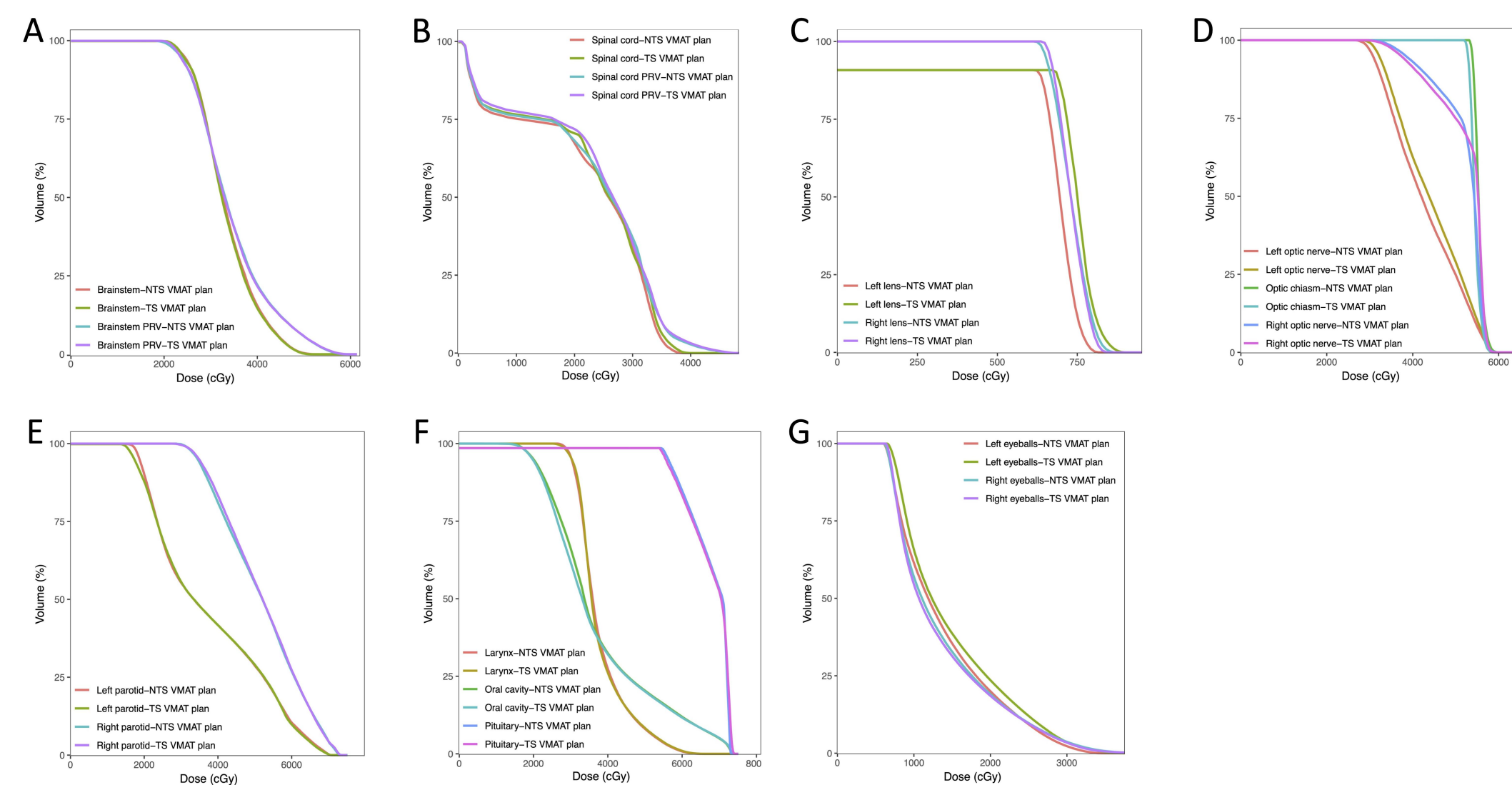


Fig.3 DVHs comparison of OARs for TS-VMAT and NTS VMAT plans of one nasopharyngeal carcinoma case in bilateral LNI group

◆ Thyroid

Table 1 Dosage distribution in the thyroid for NTS VMAT plans and TS VMAT plans

	Bilateral UNI group			One-side LNI group			Bilateral LNI group		
	NTS VMAT (Mean±SD)	TS VMAT (Mean±SD)	P	NTS VMAT (Mean±SD)	TS VMAT (Mean±SD)	P	NTS VMAT (Mean±SD)	TS VMAT (Mean±SD)	P
Thyroid Dmin (Gy)	4.20±1.28	3.83±0.86	0.005*	16.44±6.97	6.75±2.02	<0.001*	29.56±8.68	11.62±2.44	<0.001*
Thyroid Dmean (Gy)	25.73±5.00	20.52±3.00	<0.001*	38.50±4.35	27.87±5.84	<0.001*	47.04±3.55	39.03±4.45	0.005*
Thyroid Dmax (Gy)	58.06±1.02	58.22±0.86	0.605	59.14±2.13	59.66±2.21	0.046*	60.66±3.92	60.33±3.92	0.285
Thyroid V40	27.93±8.12	21.09±5.15	0.003*	49.26±14.32	33.46±12.87	<0.001*	79.70±16.21	53.94±13.47	<0.001*

CONCLUSION

TS VMAT plan appears to be a workable approach in radiotherapy planning for patients with non-distant metastatic nasopharyngeal carcinoma. The implementation of TS VMAT plan effectively reduces radiation dose to the thyroid gland compared with NTS VMAT plan, which can reduce risks of hypothyroidism without exacerbating HI, CI and irradiation dose of OARs.

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