A novel SBRT treatment planning technique to escalate central dose

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INTRODUCTION

Purpose: To explore a simple treatment planning approach for lung stereotactic body radiation therapy (SBRT) patients, focusing on enhancing the central dose by strategically adjusting the normal tissue objective (NTO) within the Eclipse™ treatment planning system.

NTO: A spatially varying one dimensional constraint in the optimization workspace that can help improve the compactness of the isodose distribution by penalizing progressively lower isodose lines as distance increases from the target.

- Manual NTO: The user can modify the dose gradient outside of the target

A recent meta-analysis has shown that escalating the dose to the target's center may improve local control

- Escalating central dose to a biological equivalent dose (BED) of 150 Gy

METHODS

- 25 previously treated lung SBRT cases were replanned to 50 Gy using a static NTO and a dynamic NTO in the Eclipse™ treatment planning software (Version 16.1.0)
- All plans were calculated on a Varian Edge using 6X-FFF and a 1400 MU/min dose rate
- Acuros (Version 16.1.0) was used for the final dose calculation

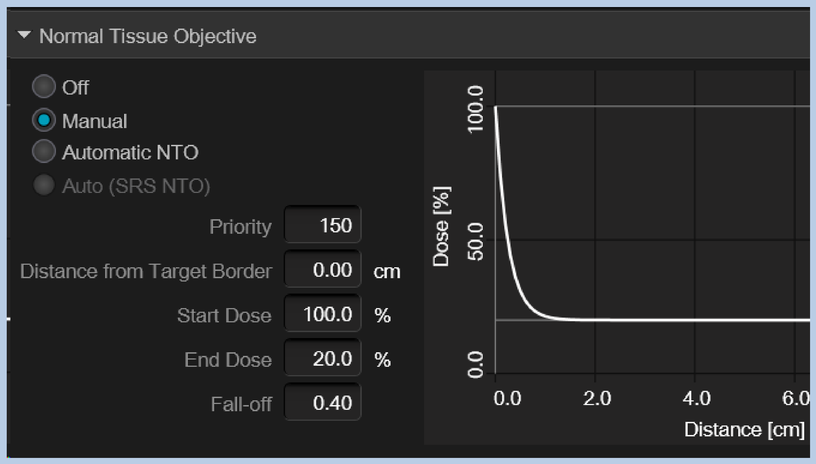
Static NTO: Plans were run with no user interaction

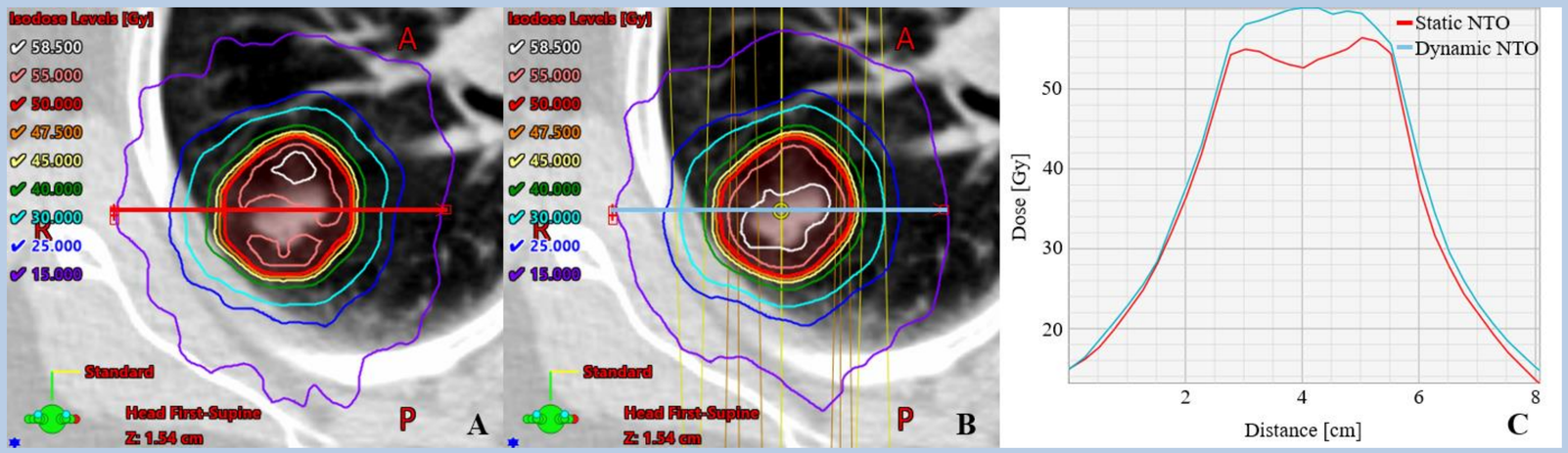
- One lower of 100% at 52 Gy with a priority of 100

Dynamic NTO: Optimization process was started then promptly paused in MR Level 1, Step 1/5

- One lower of 100% was placed around 64 Gy and an upper of 0% was placed at 65 Gy with priorities of 50
- The NTO priority was increased until 95% of the target was covered by the prescription dose (50 Gy)

- All dynamic NTO plans were planned such that the global max dose was ± 2% of the static NTO plans
- All plans were normalized such that the prescription dose covers 95% of the target volume





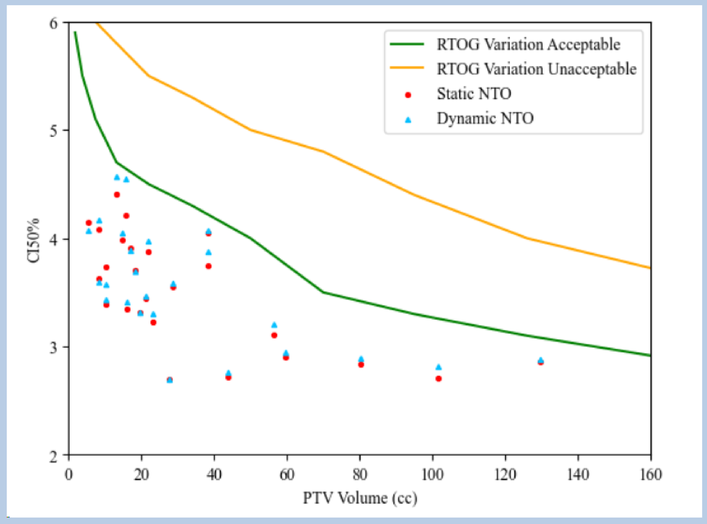
A) Static NTO isodose distribution (global max 122.3%) B) Dynamic NTO isodose distribution (global max 121.5%) C) Dose profile

	Total MUs	PTV Max Dose [Gy]	PTV Mean Dose [Gy]	ITV Max Dose [Gy]	ITV Mean Dose [Gy]	PTV-ITV Max Dose [Gy]	PTV-ITV Mean Dose [Gy]
Static NTO	4251.375	66.619	55.708	65.376	57.243	66.163	55.084
Dynamic NTO	3168.262	66.450	58.130	66.158	61.821	65.736	56.340
p-value	1.23E-04*	0.166	1.23E-05*	0.166	1.23E-05*	0.010*	1.23E-05*
BED Static NTO		155.381	117.777	150.856	122.777	153.712	115.770
BED Dynamic NTO		154.763	125.711	153.694	138.259	152.161	120.018

Dosimetric endpoints for static and dynamic NTO plans. The differences were considered significant when $p < 0.05$. An asterisk denotes a significant result.

	CI100%	CI75%	CI50%	CI25%
Static NTO	0.993	1.739	3.504	12.455
Dynamic NTO	0.986	1.727	3.552	12.846
p-value	0.028*	0.083	0.006*	8.91E-04*

CI metrics for static and dynamic NTO plans. The differences were considered significant when $p < 0.05$. An asterisk denotes a significant result.



The static and dynamic NTO plans CI50% plotted with RTOG 0813 minor and major deviations.

RESULTS

- CI100% is significantly lower for the dynamic NTO plans and the CI50% and CI25% are significantly improved for the static NTO plans
  - Absolute differences are within 3%
- There was a significant increase in PTV mean dose, ITV mean dose, and PTV-ITV mean dose in the dynamic NTO plans.
- Total MU per plan significantly decreased in the dynamic NTO plans
- No clinically meaningful differences were observed between any organs-at-risk
- All plans 50 plans generated CI100% and CI50% were within the RTOG 0813 recommended guidelines

CONCLUSIONS

This study shows the importance of an interactive NTO in escalating the central dose to a target through a straightforward treatment planning approach. The findings demonstrate the versatility of this innovative planning approach, enabling adaptation to various institutional global maximum constraints. The straightforward optimization framework is tailored for seamless integration into clinical workflows.

REFERENCES