Sharpening Dose Falloff with SBRT NTO in the Case of Lung SBRT

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Introduction

Purpose: In this study, we compared dose conformity using a two-arc, two-objective, noncoplanar VMAT template with an automatic, manual, and SBRT NTO.

- Lung SBRT is a highly precise form of radiotherapy that delivers high doses of radiation in a few fractions (typically 3-5).
- Guidelines defines by the RTOG 0813 emphasize achieving a steep dose gradient to minimize damage to surround health tissue while maximizing tumor control.
- Automatic NTO is a general spatial objective used in treatment planning to limit the dose level and prevent hot spots in health tissue surrounding the PTV.
- Manual NTO is defined by the following: distance from the PTV border, start dose, end dose, and fall-off.
- SBRT NTO is a novel optimization tool in Eclipse v18.0, specifically designed to function automatically for plans needing sharp dose falloff. SBRT NTO uses near target spatial objective to limit dose immediately beyond the target and up to 2cm away.

Methods

- 10 lung SBRT cases were replanned using a templated approach to study the effectiveness of v18 SBRT NTO in comparison to a manual or automatic NTO.
- Templates utilized two lateral 180° arcs separated by 20° couch angles, collimator angles were set to 30° and 330°, field sizes were automatically set using Arc Geometry Tool.
- One lower objective was added to the PTV to achieve dose coverage, and a MU objective was used to manage over-modulation.
- Each case has a total of three templated plans ran with an automatic, manual, and SBRT NTO.
  - The manual NTO used was set at a start dose of 101% t 0cm from the target border, a 20% end dose, and 0.15 fall-off rate.
- Dose conformity was evaluated for CI100% and CI50% of these three categories of plans.

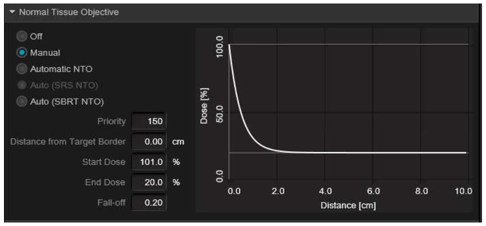

Figure 1. Manual NTO settings used for planning. Auto and SBRT NTO settings both had priority set to 150 as well.

Results

- Auto NTO plans achieved a CI50% of 3.81 and a CI100% of 0.988, while the SBRT NTO plans resulted in a CI50% of 3.70 and a CI100% of 0.99. The manual NTO approach yielded a CI50% of 3.7559 and a CI100% of 0.984.
- Statistical analysis showed a significant difference in CI50% between the automatic and SBRT NTO approaches ($p = 3.25 \times 10^{-6}$), indicating better dose conformity for the SBRT NTO.
- Additionally, the difference between SBRT NTO and manual NTO for CI50% was statistically significant ($p = 0.036$), suggesting that SBRT NTO resulted in slightly improved dose conformity compared to SBRT NTO. These findings highlight the impact of utilizing v18 SBRT NTO to achieve optimal dose conformity in lung SBRT treatment planning.

Table 1. Plan Metrics for Lung SBRT Plans with each NTO type.

Metric	SBRT	Manual	Auto
D2cm	46.4±4.6%	46.8±5.6%	47.3±4.2%
CI100	0.99±0.06	0.98±0.06	0.99±0.06
CI50	3.70±0.31	3.76±0.31	3.81±0.33
Total MU	2989±425	2460±163	3336±570

Discussion & Conclusion

- V18 SBRT NTO improves dose conformity in Lung SBRT planning compared to automatic and manual NTO approaches.
- Statistically significant differences in CI50% suggest SBRT NTO provides a sharper dose fall-off, reducing radiation exposure to healthy tissue while maintaining tumor coverage.
- Manual NTO showed slightly inferior intermediate dose conformity compared to SBRT NTO, while automatic NTO performed less effectively in achieving optimal dose gradients.
- Findings support RTOG 0813 and RTOG 0915 recommendations for dose conformity and normal tissue dose constraints in lung SBRT planning.
- Implementation of v18 SBRT NTO in clinical practice may improve treatment efficacy and safety.
- SBRT NTO effectively controls dose falloff automatically in close proximity to the target, taking guess work out from setting up Manual NTO settings.
- Future studies will investigate the potential to reduce dose bridging between multiple targets, another key feature in the newly released SBRT NTO.

Case Study

- Patient 9 presented with a peripheral RUL Lesion (PTV = 14.5cc).
- SBRT NTO (left) generated the best falloff, as evidenced by the central dose profile, while allowing for dose escalation to the ITV (purple contour).
- D2cm metrics show that SBRT NTO (43.6%) improved intermediate dose falloff as compared to Auto (43.65%) and Manual (48.64%).
- SBRT NTO also reduced chestwall D0.03cc by 1Gy compared to Manual NTO settings.

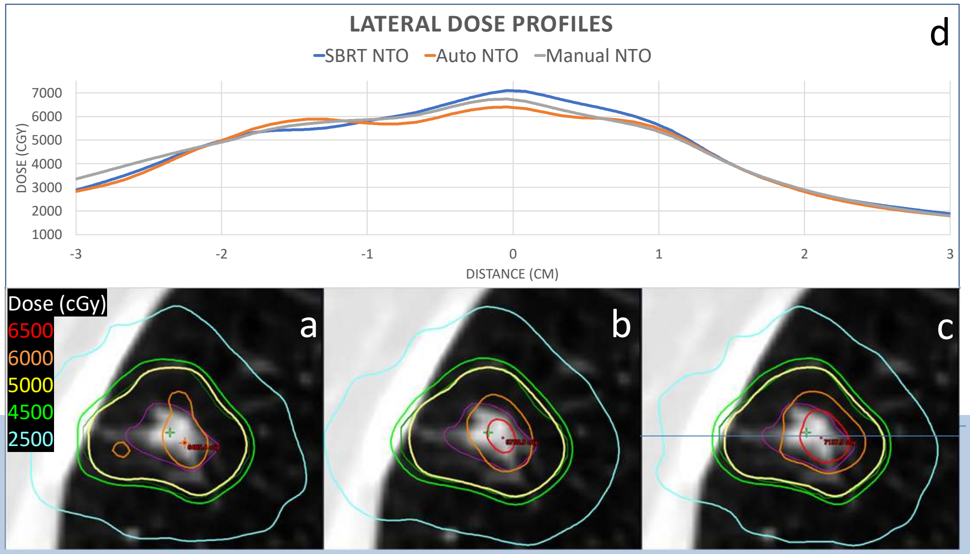

Figure 2a-d. Auto (a), Manual (b), and SBRT(c) NTO plans for Patient 9. SBRT NTO yielded improved dose falloff, as evidenced in the line dose profile (d).

References

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