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Full Dose SBRT in Combination with Mediastinal Chemoradiation for Locally Advanced Stage II Non-small Cell Lung Cancer Treatment Planning Techniques

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Introduction

Purpose

A phase II trial evaluating treating the primary lung tumor with SBRT followed by concurrent mediastinal chemoradiation for locally advanced non-small cell lung cancer was performed. Specialized dosimetry techniques utilized for this trial were evaluated.

Methods

In the current study, the primary tumor was subjected to a total radiation dose of 50-54 Gy administered over 3-5 fractions using SBRT. This was followed by mediastinal irradiation with a total dose of 60 Gy in 30 fractions using IMRT in combination with concurrent chemotherapy. To optimize treatment efficacy, two different techniques were employed depending on the proximity of the primary and nodal target volumes.

When the primary lesion was in close proximity to the nodal disease, the IMRT plan utilized base dose derived from the SBRT plan to reduce overlap. The SBRT plan was executed using a 6XFFF beam, with Acuros algorithm and a 1mm grid size, utilizing two partial arcs. The nodal treatment was carried out using Rapid Arc, a 6x beam, and Acuros algorithm.

When the primary lesion was sufficiently separated from the nodal disease, IMRT was utilized for both sites, with careful beam arrangement for the nodal volume to avoid entry through the primary tumor. The primary lesion was treated using SBRT with 6XFFF, Acuros and 1mm grid size. The nodal volumes were treated using VMAT IMRT with 6X and Acuros.

Results

In a clinical trial conducted between 2017-2022, 60 patients were enrolled and both techniques were utilized. However, when the SBRT plan was used as the base dose, it resulted in an insufficient coverage of the target volumes, which would typically be deemed unacceptable. To address this issue, a plan summation was created to assess the total coverage of the targets, ensuring that the D95% was at least 100% for the planning target volume (PTVn). The implemented planning techniques demonstrated effective organ sparing and risk reduction, thereby enabling the planner to successfully achieve the trial's objectives.

Target dose coverage requirements for plan sum

PTVp	D99%[%]	>=90	>=85
	D95%[%]	>=100	>=95
PTVn	D95%[%]**	>=100	>=95

Normal structure constraints for SBRT to the primary tumor

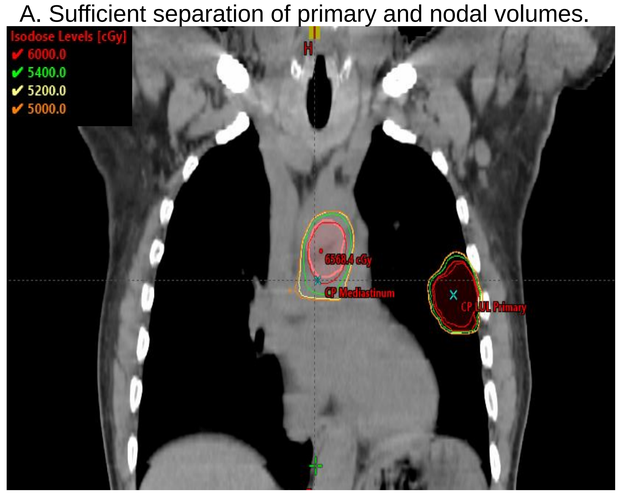
Normal Structure	3 Fractions	4 Fractions	5 fractions
Spinal Cord	18 Gy (6 Gy/fx)	26 Gy (6.5 Gy/fx)	28 Gy (5.6 Gy/fx)
Esophagus	30 Gy (10 Gy/fx)	30 Gy (7.5 Gy/fx)	38 Gy (7.6 Gy/fx)
Brachial Plexus	21 Gy (7 Gy/fx)	27.2 Gy (6.8 Gy/fx)	32.5Gy (6.5 Gy/fx)
Heart/Pericardium	30 Gy (10 Gy/fx)	34 Gy (8.5 Gy/fx)	38 Gy (7.6 Gy/fx)
Great Vessels	39 Gy (13 Gy/fx)	49 Gy (12.25 Gy/fx)	53 Gy (10.6 Gy/fx)
Trachea/Proximal Bronchi	30 Gy (10 Gy/fx)	34.8 Gy (8.7 Gy/fx)	50 Gy (10 Gy/fx)
Rib	30 Gy (10 Gy/fx)	30 Gy (7.5 Gy/fx)	57 Gy (11.4 Gy/fx)
Skin	30 Gy (10 Gy/fx)	36 Gy (9 Gy/fx)	38.5 Gy (7.7 Gy/fx
Stomach	27 Gy (9 Gy/fx)	30 Gy (7.5 Gy/fx)	35 Gy (7 Gy/fx)

*Rib dose in excess of the above constraints was documented but not a reason to necessitate subject withdrawal.

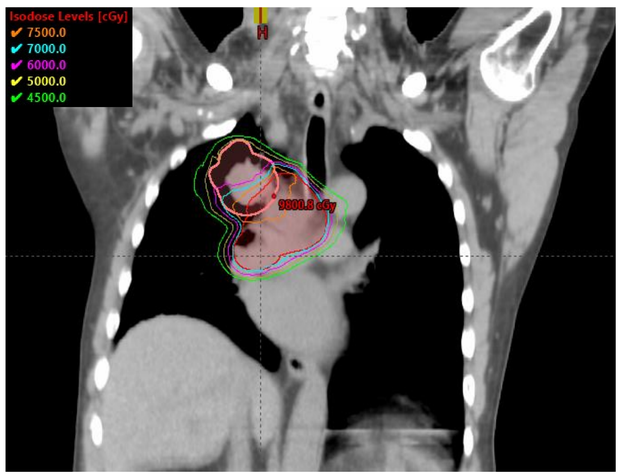
Normal structure constraints for dose summation of SBRT to the primary tumor and conventional radiation to the nodal disease

Name of Structure	Dosimetric Parameter	Per Protocol
Lungs-IGTV	V20Gy	<37%
	Mean [Gy]	<=20
Spinal Canal	D0.03cc[Gy]	<=50
Heart	V50%	<=40
Esophagus	Mean [Gy]	<34

A. Sufficient separation of primary and nodal volumes.

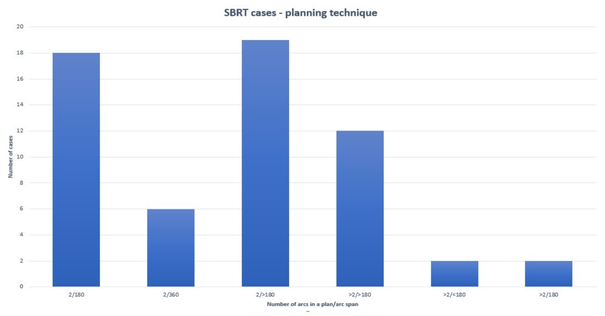


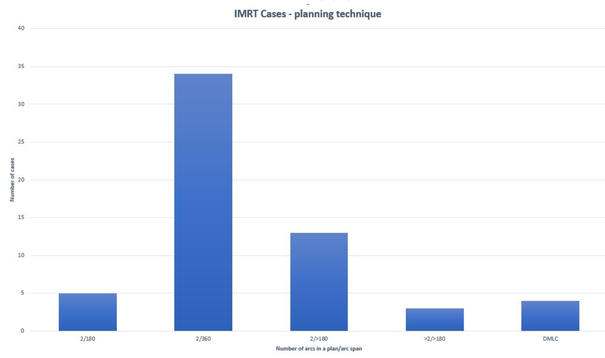
B. Close proximity/overlap of primary and nodal volumes.



Conclusion

Through the implementation of distinct treatment plans for the primary and nodal diseases, it is feasible to attain the desired therapeutic dose while concurrently mitigating detrimental effects on the organs at risk. However, prior to commencing the planning process, meticulous assessment of the proximity between the primary lesion and nodal disease is essential. For lesions in close proximity, the utilization of a base dose plan has demonstrated optimal efficacy in minimizing overlap dosing.





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