



Comparison of Scanning Beam Proton Therapy versus Photon IMRT for Stage III Non-Small Lung Cancer



M. ZERFU^{1,2}, L. FERRO^{1,3}, O. FATTY-HYDARA^{1,4}, J. ZENG¹, S. BOWEN¹, R. RENGAN¹, R. ROBERTS¹, A. SHEPHERD¹, J. KANG¹

1Department of Radiation Oncology and the Fred Hutch Cancer Center, University of Washington, Seattle, Washington, USA

2School of Medicine, University of Texas Rio Grande Valley, Edinburg, Texas, USA

3Department of Radiation Oncology, Samson Assuta Ashdod University Hospital, Ashdod, Israel

4Dartmouth College, Hanover, New Hampshire, USA

PURPOSE / OBJECTIVES

To compare Scanning-Beam Proton Therapy (SPT) and Photon IMRT/VMAT for stage III non-small cell lung cancer (NSCLC).

Focus on dosimetry, toxicity, and clinical outcomes in the modern immunotherapy era (post-PACIFIC).

Assess whether the dosimetric advantages of proton therapy translate into meaningful clinical differences.

MATERIAL & METHODS

Design: Retrospective cohort study (single institution, 2018–2024).

Patients: 95 stage III NSCLC patients (63 SPT, 32 IMRT).

Treatment: Definitive chemoradiation (≥50 Gy); most received concurrent chemo and adjuvant immunotherapy.

Data collected:

Baseline demographics and tumor characteristics.

Radiation dose-volume metrics (lung V5, V20, esophagus V30, mean heart dose, etc.).

Clinical outcomes: OS, PFS, locoregional control.

Toxicity: pneumonitis, esophagitis, dermatitis, cardiac events.

Analysis: Chi-square/Fisher's exact for categorical, Welch's t-test for continuous, Kaplan–Meier/log-rank for survival.

RESULTS

Tumor Size: Proton cohort had larger PTVs (450 vs 350 mL, p=0.039).

Dosimetry: Lower lung V5 with protons (30% vs 50%, p<0.01).

Mean lung dose and V20 similar between groups.

Esophageal and cardiac doses largely comparable.

Toxicity: No significant differences in Grade ≥ 3 events.

Slightly more grade 1 dermatitis in IMRT; pneumonitis rates similar.

Outcomes: No significant difference in Overall Survival or Progression-Free Survival

Locoregional control comparable.

Even though patients treated with proton therapy had significantly larger tumors, clinical outcomes, including locoregional control, toxicity, and survival, remained comparable to photon therapy.

SUMMARY / CONCLUSION

SPT can safely treat larger, more complex tumors without compromising outcomes.

Clinical outcomes (OS, PFS, toxicity) were comparable between protons and photons.

Dosimetric advantage: lower lung V5 with protons, which may help in reducing long-term pulmonary toxicity.

Implication: Supports selective use of proton therapy for anatomically challenging stage III NSCLC cases, especially in the immunotherapy era.

RESULTS

Dosimetric Comparison

Characteristic		All	Protons	Photons	p-value
Perscription Dose (Gy), mean (range)		60.99 (60.00-66.60)	61.50 (60.00-66.60)	60.00 (60.00)	0.003
Acutal Dose Given to Target Volumes	D95 CTV (Gy)	60.60 (37.49-68.25)	60.76 (57.46-68.25)	60.29 (37.49-61.67)	0.002
	D95 PTV (Gy)	60 (32.45-66.66)	60.14 (57-66.66)	59.05 (32.45-60.77)	0.001
Volumes, mean (range)	PTV (cm³)	416.9 (56.30-1241.15)	450.8 (88.08-1241.15)	350.15 (56.30-779.84)	0.039
	Lung (cm³)	3488.29 (1803.14-6719.25)	3339.13 (1803.14-6719.25)	3781.94 (2131.82-6105.24)	0.042
	PTV/Lung Ratio	0.129 (0.02-0.42)	0.143 (0.03-0.42)	0.101 (0.02-0.29)	0.015
Dosimetric comparison					
Lung	Mean Dose (Gy)	11.59 (1.43-19.99)	11.29 (1.43-19.85)	12.19 (5.81-19.99)	0.276
	V5 (%)	36.25 (5.90-67.00)	30.02 (5.90-55.97)	49.79 (29.00-67.00)	<0.001
	V20 (%)	21.12 (2.06-39.96)	21.27 (2.06-39.96)	20.81 (4.81-36.50)	0.804
Esophagus	Mean Dose (Gy)	21.64 (0.46-46.79)	21.82 (0.46-46.79)	21.28 (4.00-41.34)	0.811
	V30 (%)	33.33 (0.00-72.89)	34.25 (0.00-72.00)	31.37 (0.44-72.89)	0.500
	V60 (%)	10.22 (0.00-56.00)	12.38 (0.00-56.00)	5.69 (0.00-33.46)	0.003
Heart	Mean Dose (Gy)	6.47 (0.54-26.86)	5.82 (0.54-21.53)	7.75 (0.71-26.86)	0.136
	V45 (%)	4.88 (0.00-28.10)	5.25 (0.00-28.10)	4.10 (0.23.00)	0.332

Treatment Toxicities

	All (total 95)	Protons (total 63)	Photons (total 32)	p-value
Pneumonitis, n. (%)				
None	41 (43.16)	22 (34.92)	19 (59.38)	0.023
Grade 1	22 (23.16)	16 (25.40)	6 (18.75)	0.468
Grade 2	25 (26.32)	20 (31.75)	5 (15.63)	0.092
Grade 3	6 (6.32)	5 (7.94)	1 (3.13)	0.362
Grade 4	1 (1.05)	0	1 (3.13)	0.474
Esophagitis				
None	44 (46.32)	32 (50.79)	12 (37.50)	0.219
Grade 1	23 (24.21)	14 (22.22)	9 (28.13)	0.526
Grade 2	27 (28.42)	17 (26.98)	10 (31.25)	0.663
Grade 3	0	0	0	/
Grade 4	1 (1.05)	0	1 (3.13)	0.474
Dermatitis				
None	64 (67.37)	46 (73.02)	18 (56.25)	0.100
Grade 1	24 (25.26)	12 (19.05)	12 (37.50)	0.050
Grade 2	6 (6.32)	4 (6.35)	2 (6.25)	0.985
Grade 3	1 (1.05)	1 (1.59)	0	0.474
Grade 4	0	0	0	/
Cardiac				
IMACE events	12 (12.63)	10 (15.87)	2 (6.25)	0.182
Any cardio-pulmonary event	18 (18.95)	13 (20.63)	5 (15.63)	0.556
Weight loss				
None	56 (58.95)	36 (57.14)	20 (62.50)	0.616
Grade 1	29 (30.53)	19 (30.16)	10 (31.25)	0.913
Grade 2	8 (8.42)	6 (9.52)	2 (6.25)	0.432
Grade 3	1 (1.05)	1 (1.59)	0	0.474
Unknown	1 (1.05)	1 (1.59)	0	/

