Scanning Beam Proton Therapy versus Photon IMRT For Stage III Lung Cancer: comparison of dosimetry, toxicity and outcomes

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INTRODUCTION

- There is limited clinical data on scanning-beam proton therapy (SPT) in treating locally-advanced lung cancer, and increasing interest in whether dosimetric advantages of can translate into superior clinical outcomes over photon therapy.
- We present our experience of SPT and photon intensity-modulated radiation therapy (IMRT) with real-life dosimetry, and outcomes in patients with stage III lung cancer.

METHODS

- Patients with stage III lung cancer treated at our center between 2013-May 2018 were identified in compliance with an IRB-approved study (64 patients=34 SPT +30 IMRT).
- Most proton patients were treated with pencil beam scanning (28/34), 6/34 with uniform scanning.
- Fisher’s exact test, Chi-square test, and Mann-Whitney test were used to compare groups. All tests were two-sided.

RESULTS

- Mean dose to lung, heart, and esophagus were lower in the SPT group, with most benefit in the low dose region (Fig. 1 &Table 2).
- Grade 2+ pneumonitis rate was 21% in the SPT group and 40% in the IMRT group (p=0.1). Esophagitis and dermatitis grades were not different between the two groups (Table 3).
- Overall survival and progression free-survival were not different between SPT and IMRT.

CONCLUSIONS

- Scanning beam proton therapy in stage III lung cancer can lower dose to normal organs compared with IMRT.
- There is no statistically significant difference in toxicity rates or survival, although there may be a trend towards less pneumonitis.

Figure 1. Dosimetric Comparison Between Protons & IMRT.

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Table 1. Patient Characteristics.

Characteristic	ALL, No.(%)	Proton No.(%)	IMRT No. (%)	P
No. of patients	64	34	30	
Sex				
Female	41(64.1)	21(61.8)	20(66.7)	0.796
Male	23(35.9)	13(38.2)	10(33.3)	
Median age,years	67(25-90)	67(25-85)	66(35-90)	0.463
<65	28(43.8)	16(47.1)	12(40)	0.62
≥65	36(56.3)	18(52.9)	18(60)	
Ethnicity				
White	53(82.8)	28(82.4)	25(83.3)	0.989
Black	4(6.2)	2(5.9)	2(6.7)	
Asian	2(3.1)	1(2.9)	1(3.3)	
Others	5(7.8)	3(8.8)	2(6.7)	
ECOG				
0-1	61(95.3)	32(94.1)	29(96.7)	1
2	3(4.7)	2(5.9)	1(3.3)	
>2	0	0	0	
Smoking history				
Never	7(10.9)	6(17.6)	1(3.3)	0.109
Ever	57(89.1)	28(82.4)	29(96.7)	
Median FEV1, L (range)	2.2(0.83-4.2)	2.35(0.83-4.2)	1.78(0.96-3.38)	0.08
Median FEV1, % predicted (range)	75.5(39-149)	84(44-149)	66(39-113)	0.02
Median DLCO, % predicted (range)	63(33-102)	65(33-102)	62(35-90)	0.344
Stage				
IIIA	23(35.9)	12(35.3)	11(36.7)	0.824
IIIB	37(57.8)	19(55.9)	18(60)	
IIIC	4(6.3)	3(8.8)	1(3.3)	
Tumor histology				
Adenocarcinoma	36(56.3)	19(55.9)	17(56.7)	0.74
Squamous cell carcinoma	21(32.8)	11(32.4)	10(33.3)	
NSCLC unspecified	1(1.6)	0(0)	1(3.3)	
Small cell	6(9.4)	4(11.8)	2(6.7)	
Concurrent chemotherapy				
Yes	43(67.2)	19(55.9)	24(80)	0.061
No	21(32.8)	15(44.1)	6(20)	
Immunotherapy				
Yes	23(35.9)	15(44.1)	8(26.7)	0.1974
No	41(64.1)	19(55.9)	22(73.3)	

Table 2. Dosimetric Comparison.

Characteristic	ALL	Proton	IMRT	P
Prescription dose in Gy(CGЕ)	61.2(50.4-74.25)	61.2(50.4-74.25)	61.5(50.4-66.6)	0.82
Median target volumes,cm3(range)				
PTV	599.1(94.1-1639)	607.9(94.1-1243)	587.6(135.3-1639)	0.845
GTV	156.1(1.39-647.8)	173.5(1.39-486.3)	131.5(28.2-647.8)	0.445
CTV	370(37.49-1202)	382.5(37.5-729.3)	334.2(45.81-1202)	0.755
Lung-PTV				
Mean dose in Gy (CGЕ)	13.09(1.28-19.77)	9.7(4.87-17.53)	15.77(1.28-19.77)	< 0.0001
V5(%)	39.14(5.01-70.67)	29.02(15.55-70.7)	57.53(5.01-69.34)	< 0.0001
V20(%)	24.69(1.66-35.55)	18.81(9.51-35.44)	27.98(1.66-35.55)	< 0.0001
V60(%)	1.25(0-12.48)	1.85(0-12.48)	1.1(0-5.96)	0.245
Esophagus				
Mean dose in Gy (CGЕ)	29.76(10.78-60.43)	28.19(10.78-54.1)	30.91(17.67-60.4)	0.023
V10(%)	58.28(30.39-98.5)	56.1(30.39-97.06)	64.53(37.99-98.5)	0.007
V60(%)	15.26(0-79.16)	16.52(0-78.81)	14.6(0-79.16)	0.715
Heart				
Mean dose in Gy (CGЕ)	11.65(0-39.51)	6.95(0-39.51)	14.04(0-35.43)	0.001
V5(%)	32.16(0-100.0)	22.12(0-100)	55.44(0-98.39)	< 0.0001
V30(%)	13.2(0-83.45)	10.86(0-83.45)	18.06(0-58.18)	0.0202
V60(%)	1.49(0-20.91)	1.17(0-20.36)	1.535(0-20.91)	0.838
Spinal Cord				
D0.03cc Gy (CGЕ)	43.78(0.63-53.35)	37.54(0.63-49.96)	45.83(31.4-53.35)	< 0.0001

Table 3. Treatment Toxicities.

	ALL	Proton	IMRT	P
Esophagitis grade				
Grade0-1	26(40.6)	12(35.3)	14(46.7)	0.842
Grade≥2	38(59.4)	22(64.7)	16(53.3)	
Pneumonitis grade				
Grade0-1	45(70.3)	27(79.4)	18(60)	0.107
Grade≥2	19(29.7)	7(20.6)	12(40)	
Acute dermatitis grade				
Grade0-1	42(65.6)	20(58.8)	22(73.3)	0.294
Grade≥2	22(34.4)	14(41.2)	8(26.7)	
Acute weight loss (lbs)				
Grade0-1	58(90.6)	30(88.2)	28(93.3)	0.345
Grade≥2	6(9.4)	4(11.8)	2(6.7)	