

Proton Therapy Posterior Beam Approach with PBS for Esophageal Cancer: Clinical Outcome, Dosimetry, & Feasibility

May 27th, 2016

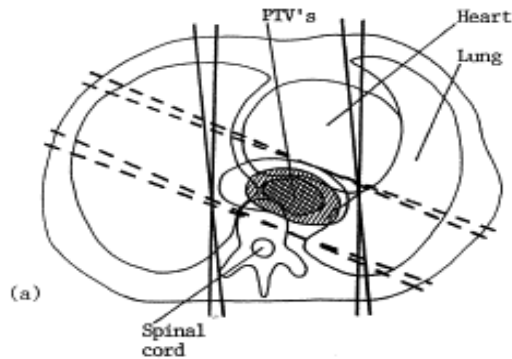
Jing Zeng, M.D.

University of Washington/Seattle Proton Therapy Center

Disclosures

- None.

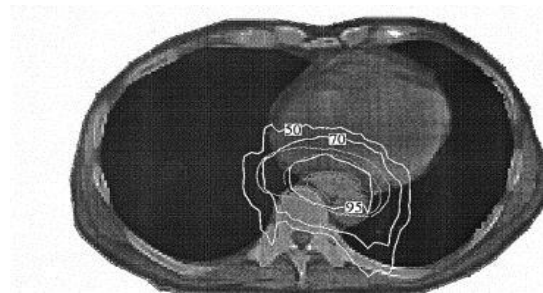
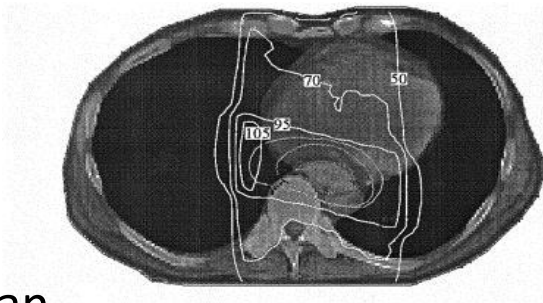
Comparison Planning

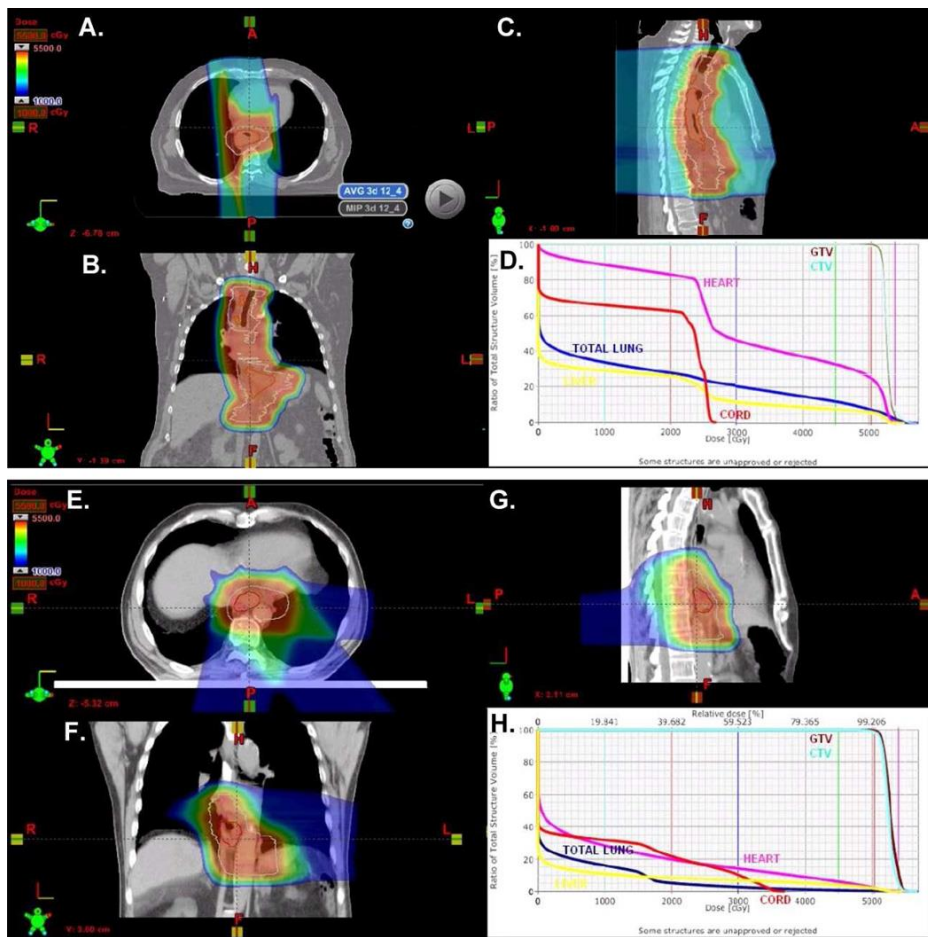


Beam limits for:
—— initial PTV (PTV1)
- - - - initial boost PTV (PTV2)
- · - · second boost PTV (PTV3)

Top: 4-beam x-ray plan

Bottom: Proton plan



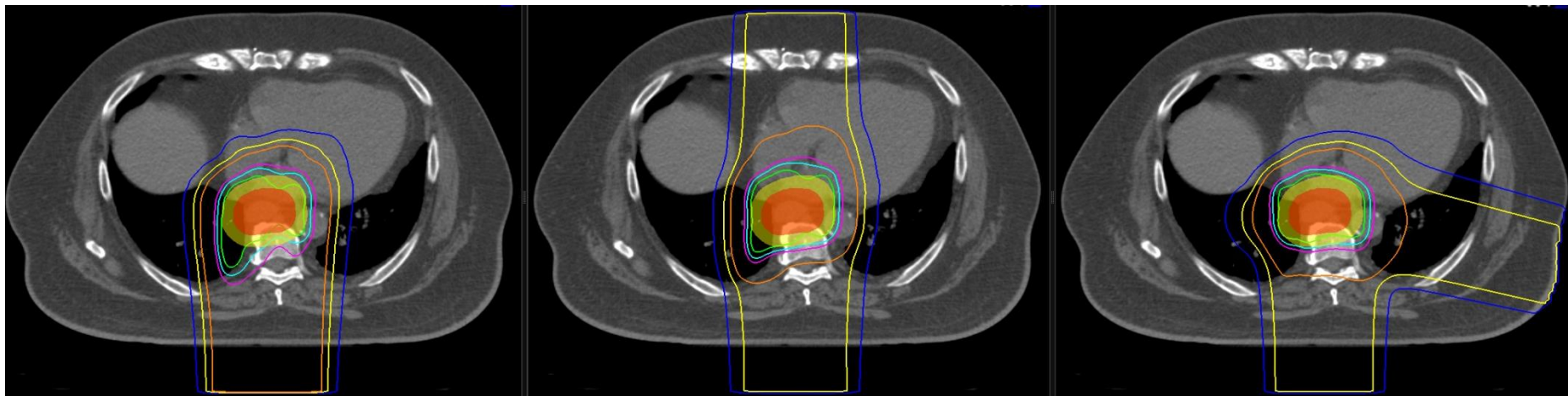


Protons for Esophageal Cancer in Seattle

- Center opened 2013
- Started esophageal treatment in gantry with uniform scanning in 2014
- Mostly distal esophageal adenocarcinoma

Protons for Esophageal Cancer in Seattle

- Switched from US to PBS in 2015 on gantry
 - Beam arrangement?
 - Motion?



Our Study

- 2/2014 to 6/2015, 13 patients with esophageal cancer
 - T3-4N0-2M0, 11 adenocarcinoma, 2 squamous cell carcinoma
 - All treated with intent for trimodality therapy (chemorads+surgery)
 - 50.4 CGE in 1.8 CGE daily fractions with weekly carboplatin/paclitaxol
 - 12 patients went ahead to surgery, 1 developed metastatic disease
 - 8 patients with uniform scanning, 5 patients single PBS beam (volumetric rescanning for motion mitigation)
- Comparison planning with PBS was performed using 3 plans: AP/PA, PA +LPO, & single PA beam

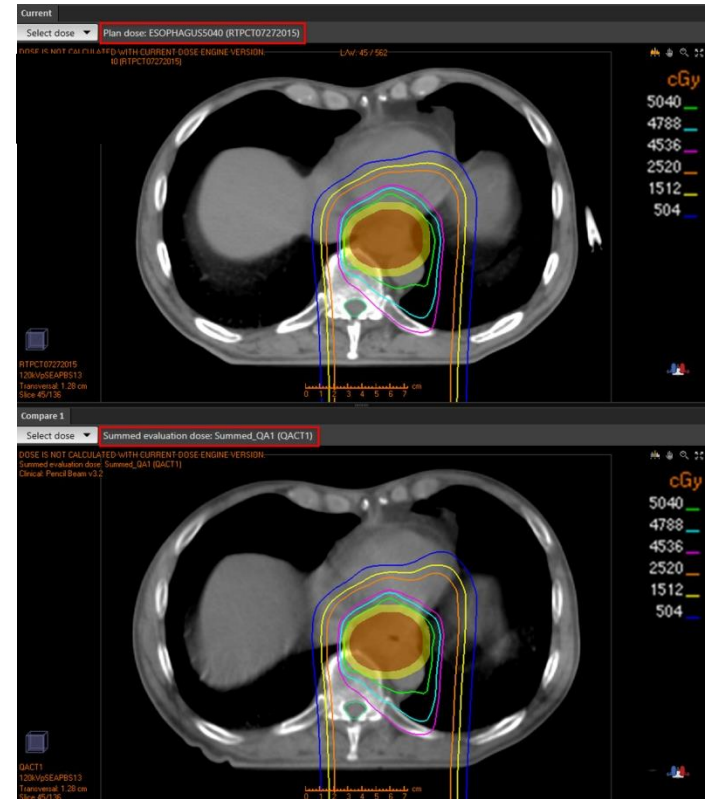
Dosimetry of a Single Posterior Beam

Organ	PA Plan	AP/PA Plan	PA/LPO Plan	P-value (PA vs AP/PA)	P-value (PA vs PA/LPO)	P-value (AP/PA vs PA/LPO)
GTV						
Mean dose (Gy)	50.40 ± 0.00	50.40 ± 0.00	50.40 ± 0.00			
Heart						
Mean dose (Gy)	14.10 ± 3.28	24.49 ± 3.38	15.04 ± 4.39	0.000	0.554	0.000
V5	43.61 ± 8.69	85.83 ± 8.85	47.68 ± 10.52	0.000	0.318	0.000
V30	23.97 ± 6.00	31.48 ± 6.78	26.85 ± 7.73	0.020	0.715	0.020
Lung						
Mean dose (Gy)	4.96 ± 2.00	5.25 ± 1.84	7.15 ± 2.36	0.745	0.020	0.040
V5	16.82 ± 6.42	22.08 ± 6.49	29.07 ± 10.37	0.133	0.001	0.049
V20	10.10 ± 4.11	10.26 ± 4.39	17.14 ± 5.25	0.936	0.001	0.001

Organ	PA Plan	AP/PA Plan	PA/LPO Plan	P-value (PA vs AP/PA)	P-value (PA vs PA/LPO)	P-value (AP/PA vs PA/LPO)
Spinal cord						
Maximal dose (Gy)	44.50 ± 1.09	35.79 ± 7.85	35.15 ± 5.93	0.001	0.001	0.549
Stomach						
Mean dose (Gy)	22.95 ± 10.13	31.33 ± 8.08	25.33 ± 8.82	0.038	0.542	0.130
V5	59.99 ± 20.09	91.54 ± 11.26	65.48 ± 17.38	0.000	0.445	0.001
Left kidney						
Mean dose (Gy)	5.30 ± 4.14	3.38 ± 2.91	7.92 ± 3.85	0.231	0.104	0.007
V20	11.64 ± 10.13	4.79 ± 5.81	13.24 ± 9.21	0.071	0.667	0.028
Liver						
Mean dose (Gy)	3.79 ± 1.28	5.75 ± 1.45	4.63 ± 1.64	0.004	0.381	0.032
V30	5.90 ± 2.17	7.05 ± 2.60	6.94 ± 2.61	0.282	0.328	0.919

Feasibility

- Daily X-ray image guidance
- All patients underwent quality assurance repeat CT simulation scan (slow scan) at 15 Gy and 30 Gy
- Check target coverage (CTV99% of prescription dose > 95% volume) and normal tissue constraints
- No re-planning was needed for any of the patients



Clinical Outcome

- 12 patients underwent surgery, pathologic complete response (pCR) rate 25%
 - R0 resection was achieved in all 12 patients
 - Down-staging in T and N stages occurred in 92% and 50% of the patients, respectively
 - Median fu 11 months, median PFS and OS not reached (3 patients had recurrent disease, all distant)
- US versus PBS
 - Same pCR rate was seen in both groups (25%)
 - Similar rates of tumor and nodal down-staging

Toxicity

- All patients received full dose of radiation and chemo cycles
- No grade 4-5 toxicity during chemoradiation
- No significant differences between US and PBS
- One post-op death

Toxicity	Grade 2 toxicity			Grade 3 toxicity		
	PBS (n=5)	US (n=8)	P value	PBS (n=5)	US (n=8)	P value
Neutropenia	0(0)	0(0)	1.000	0(0)	1(13%)	0.312
Thrombopenia	0(0)	1(13%)	0.312	0(0)	0(0)	1.000
Anemia	2(40%)	2(25%)	0.571	0(0)	0(0)	1.000
Nausea	1(20%)	2(25%)	0.834	0(0)	1(13%)	0.312
Fatigue	1(20%)	2(25%)	0.834	0(0)	0(0)	1.000
Radiation dermatitis	1(20%)	4(50%)	0.565	0(0)	0(0)	1.000
Esophagitis	0(0)	3(38%)	0.231	0(0)	1(13%)	0.312

Conclusions

- Proton therapy with a single PA beam PBS technique for preoperative treatment of esophageal cancer appears safe and feasible
- Potentially offers dosimetric advantages over other beam arrangements
- Small patient numbers, short follow up

Acknowledgments

- Yue-Can Zeng
- Shilpa Vyas
- Quang Dang
- Lindsay Schultz
- Stephen R. Bowen
- Tony Wong
- Smith Apisarnthanarax
- PCG Registry



Proton
Collaborative
Group

Research. Innovation. Results.