Clinical Implementation of Robust Proton Lattice Planning Strategy

Sina Mossahebi, Jenna Jatczak, Baoshe Zhang, Jason Molitoris, Pranshu Mohindra, William Regine, Byongyong Yi

Radiation Oncology, University of Maryland School of Medicine, Baltimore, MD, USA

BACKGROUND:

Pencil beam scanning (PBS) proton therapy provides an alternate approach to deliver 3D-spatially fractionated lattice radiation therapy, however, it hasn't been fully utilized in the clinics.

Existing limitations include degradation in plan quality with single-field and in plan robustness with multi-field lattice plans.

AIM:

We developed a robust proton lattice planning method using multiple fields and evaluated its dosimetric characteristics to clinically acceptable photon lattice treatment.

MATERIALS/METHODS:

- In seven patients (3 lung, 3 pelvis and 1 abdomen) previously treated with photon lattice therapy, PBS lattice plan was developed
- Two orthogonal beams were use: the primary beam (PB) and a robust complementary beam (RCB) that deliver 67% and 33% of the prescribed dose, respectively, to 1cm-diameter vertices with 3.2-3.5cm spacing inside the target.
- Only RCB was robustly optimized using 5mm setup and 3.5% range uncertainties.
- The number and total volume of vertices as well as the dosimetric parameters such as peak-to-valley dose ratios (PVDR) defined as D10/D90 of GTV, and volume of low dose to GTV of two plans (proton and photon) were compared.

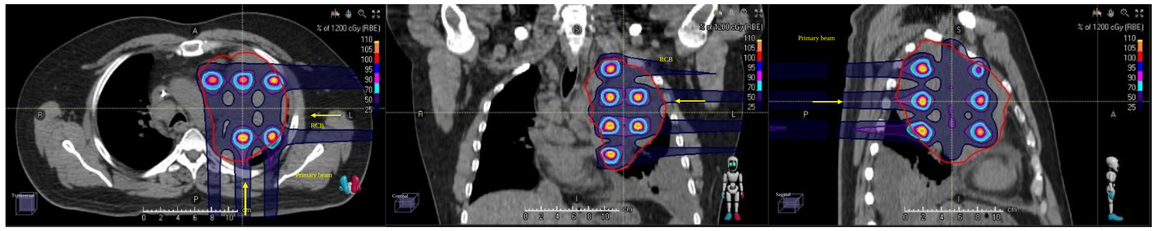

Figure 1. *Dose distribution of proton lattice plan with a pair of primary and robust complimentary beams.*

RESULTS:

- Compared to proton lattice plans without robust optimization, The RCB strategy improved the robustness of plans and achieve the planning goals (>95% of vertice volumes covered by 95% of prescription dose) under the position and range uncertainty conditions.
- The patient specific quality assurance and end-to-end test was successfully performed.

RESULTS:

- Compared to photon plans, on average 30% more number of vertices can be obtained using proton lattice plans. Furthermore, a larger volume of vertices (18.2±25.9cc vs. 12.2±14.5cc) and higher PVDR (10.5±4.8 vs. 2.5±0.9, p<0.005) were observed for proton lattice plan compared to those of photon.

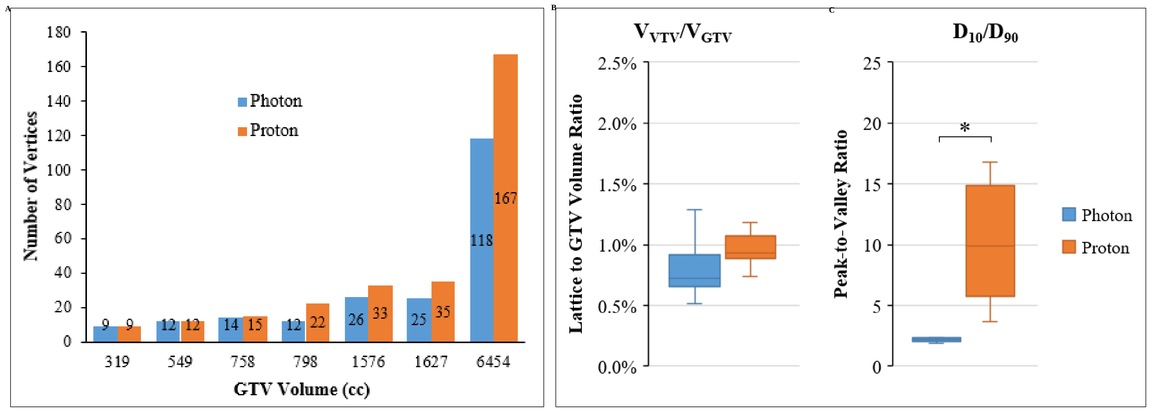

Figure 2. *Proton and photon lattice plan comparison for A) number of vertices, B) vertices to GTV volume ratio, C) PVDR (D90/D10).*

- Additionally, proton lattice plans show less low dose to GTV volume than those of photon, V30%: 60.9±7.2% vs. 81.6±13.9% and V10%: 88.3±4.5% vs. 98.6±3.6% (p<0.01).

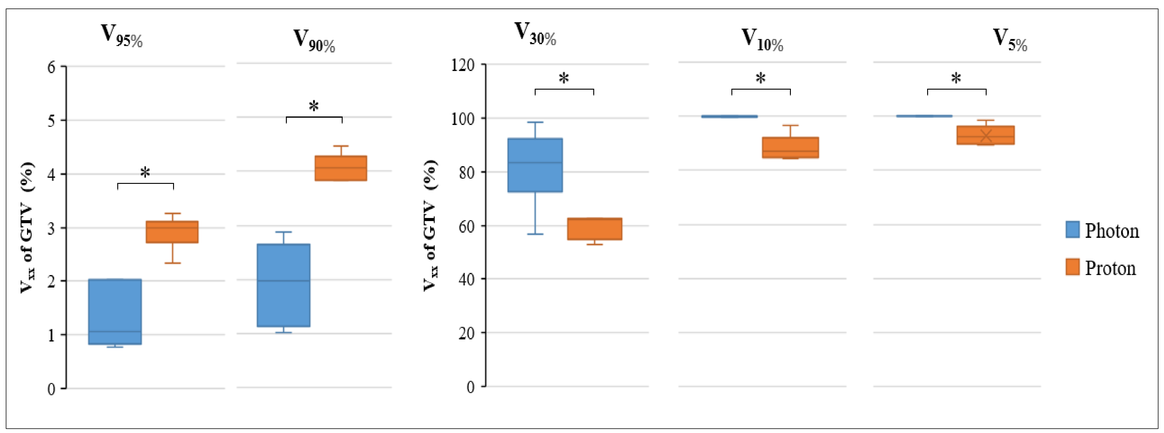

Figure 3. *GTV high and low dose volume comparison of photon and proton lattice plans. Vxx%: volume receiving xx% of the prescription dose..*

CONCLUSION:

Robust proton lattice planning strategy using a pair of primary and robust complimentary beams has been successfully commissioned.

The proposed planning method can generate plans with better quality, more number of vertices, and higher PVDR than clinically acceptable photon lattice plans.

CONTACT INFORMATION:

Sina Mossahebi, PhD

Associate Professor
Maryland Proton Treatment Center
Department of Radiation Oncology
University of Maryland School of Medicine
sinamossahebi@umm.edu