# Treatment of Acoustic Neuromas with Spot Scanning Proton Stereotactic Radiotherapy: Dosimetric Comparison to Linac-based SRT

Mattison Flakus, Ph.D.[1], Rory Miller II[2], Martin Bues, Ph.D.[1], Jiajian Shen, Ph.D.[1], Edward Clouser, M.S.[1], Pedro Lara, C.M.D.[1], Sujay Vora, M.D.[1]

[1]Division of Radiation Oncology, [2]Wofford College

## ABSTRACT

### OBJECTIVE

Linac-based stereotactic radiotherapy (SRT) is used to treat intracranial lesions, being particularly valuable for targets close to organs at risk (OAR). Our institution implemented proton SRT recently and is investigating conditions that may benefit from known dosimetric advantages of protons. Large acoustic neuromas respond to radiation and can impinge on the brainstem and cochlea. We performed a treatment planning comparison of proton and linac SRT for treatment of large acoustic neuromas.

### METHODS

8 patients with acoustic neuromas (0.8-12cc) treated with 5-fraction linac SRT were retrospectively identified and replanned for proton SRT. Clinical plans were created using volumetric modulated arc therapy, while proton plans used pencil-beam scanning with patient specific brass apertures. Both were optimized to meet institutional plan goals. Proton SRT plans were normalized to match achieved linac SRT target coverage and evaluated for ipsilateral cochlea, brainstem, and healthy brain sparing.

### RESULTS

Dose metrics were compared via two-tailed, paired t-tests. Relative to linac SRT, proton SRT significantly reduce mean and maximum doses to the ipsilateral cochlea (mean: 1718 vs 889 cGy, max: 2417 vs 2056, P<0.01) with average percent differences of 50% and 19%, respectively. Healthy brain doses were also significantly reduced in terms of mean and V12cc dose (P<0.01). However, brainstem max dose and V23Gy were not significantly different between linac and proton SRT (P=0.18, P=0.44).

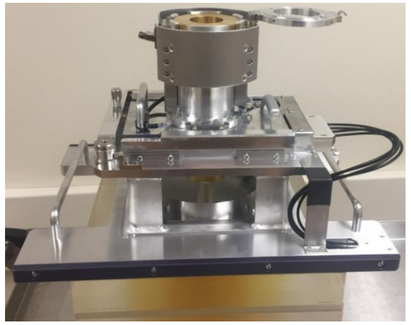
### CONCLUSIONS

Spot scanning proton SRT showed potential to reduce radiation dose to OARs compared to linac-based SRT with equivalent target coverage. Specifically, cochlear and healthy brain doses were significantly reduced, but brainstem dose was not significantly affected. Since our institutional cochlear dose constraint matches the typical prescription of these cases (25 Gy), the reduced cochlear dose may have a meaningful impact on patient's post-treatment hearing.

## METHODS 1

- 8 clinically delivered linac-based SRT plans generated using Eclipse TPS were retrospectively reviewed
- Comparison proton SRT treatment plans were generated using RayStation TPS
  - Beam specific brass apertures (**Figure 1**) were designed in planning to sharpen beam penumbra
  - Template beam angles were determine

FIGURE 1

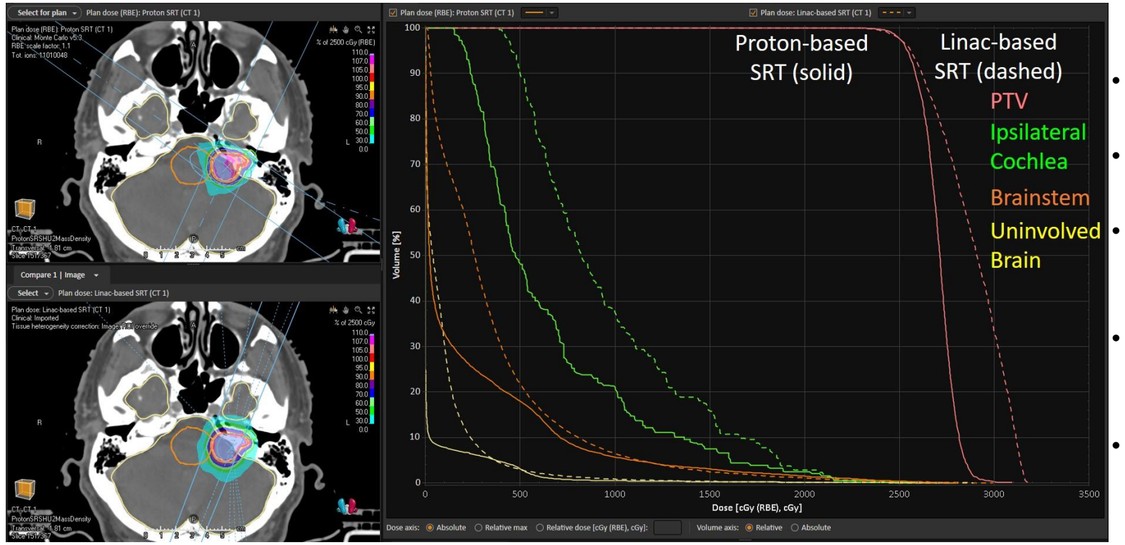


Scanning nozzle with brass aperture.

## METHODS 2

- DVH metrics were quantitatively compared between linac- and proton-based SRT plans

FIGURE 2




Treatment plan comparison between clinically delivered linac-based (bottom image, dashed DVH) and proton (top image, solid DVH) SRT.

## RESULTS

- **Figure 2** shows comparative DVHs from one patient
- **Table 1** lists DVH metrics for all patients
- Proton SRT ***significantly*** reduced mean and maximum dose to ipsilateral cochlea
- Proton SRT ***significantly*** reduced mean and V12 cc dose to healthy brain tissue
- Proton SRT ***did not significantly*** impact dose to the brainstem

TABLE 1: DVH METRIC COMPARISON

| Patient | Proton SRT | | | Linac-based SRT | | |
|---|---|---|---|---|---|---|
| | Ipsilateral Cochlea Mean / Max (cGy) | Brainstem V23 (cc) / Max (cGy) | Healthy Brain V12 (cc) | Ipsilateral Cochlea Mean / Max (cGy) | Brainstem V23 (cc) / Max (cGy) | Healthy Brain V12 (cc) |
| 1 | 227 / 453 | 0 / 1333 | 7.86 | 681 / 996 | 0 / 1450 | 14.35 |
| 2 | 1169 / 2518 | 1.65 / 1623 | 14.66 | 1516 / 2668 | 1.04 / 2749 | 18.43 |
| 3 | 11/32 / 2685 | 0.46 / 2865 | 8.30 | 2527 / 2996 | 0.40 / 2801 | 16.36 |
| 4 | 1053 / 2415 | 0.27 / 2793 | 6.63 | 2121 / 2893 | 0.35 / 2800 | 11.38 |
| 5 | 415 / 2310 | 0.19 / 2777 | 5.71 | 965 / 2407 | 0.16 / 2995 | 8.30 |
| 6 | 838 / 2296 | 0 / 2393 | 6.03 | 1791 / 2509 | 0.08 / 2870 | 7.31 |
| 7 | 707 / 1158 | 0.18 / 2784 | 3.98 | 1839 / 2089 | 0.20 / 2685 | 6.67 |
| 8 | 1568 / 2613 | 0 / 1116 | 0.84 | 2306 / 2775 | 0 / 1122 | 1.01 |

## CONCLUSIONS & FUTURE WORK

- Proton SRT shows potential to reduce cochlea and healthy brain tissue dose in treatment of acoustic neuromas
- Robustness analysis needs to be incorporated
- LET optimization capabilities may further improve treatment plans