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Optimizing Film Delivery for Patient-Specific QA for Trigeminal Neuralgia

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INTRODUCTION

- Trigeminal Neuralgia (TN) is a neurological disorder characterized by sudden severe episodes of facial pain
- TN can be treated using external beam radiotherapy using the virtual cone technique to deliver 80 Gy to a 5 mm sphere[1].
- Film measurements are often performed for patient-specific QA. Dmax is scaled to 20 Gy to fit in film dose ranges(< 40 Gy for EBT-XD).
- Figure-1 shows how the gantry speed and dose rate changes when scaling a TN plan to a Dmax of 20 Gy. Delivering such a plan will not reflect the mechanical reality of the treatment.
- This study aims to compare two patient-specific quality assurance measurements for trigeminal neuralgia (TN) treatments to ensure that the QA delivery matches the mechanical treatment limitations.

METHODS AND MATERIALS

- Verification plans were generated from five patient plans used to treat TN
- Dmax from 70-85Gy using ten partial arcs.
- Two verification plans, scaled-dose and five-arc, were created for all patients.
- Scaled-dose: Clinical Dmax was reduced to 20Gy, then dose was mapped to a cylindrical polystyrene phantom.
- Five-arc: Clinical plan mapped onto the phantom then every second treatment arc was deleted.
- Plans were delivered using a Varian TrueBeam Edge with a single EBT-XD film placed at isocenter.
- Film doses were compared to exported dose planes.
- The dose distribution full-width half-max (FWHM) values were measured in X, Y, and radial directions.
- Radial FWHMs were calculated by averaging all pixel values at each radial distance from Dmax and computing the FWHM on the resulting array.

RESULTS

- Table 1 shows the measured FWHM values for delivered plans and Table 2 compares measured FWHM with expected FWHM.
- Figure 2 shows two example film scans for the same plan showing a sub-millimeter shift in Dmax.

Table 1. Mean FWHM for scaled dose and five-arc plans

	X (mm)	Y (mm)	Radial (mm)
Scaled Dose	5.23±0.21	5.07±0.17	4.89±0.11
Five-Arc	5.3±0.25	5.15±0.21	4.99 ±0.12

Table 2. FWHM mean difference between delivered plan and exported plans

	X (mm)	Y (mm)	Radial (mm)
Scaled Dose	-0.69±0.25	-0.75±0.2	-0.47±0.16
Five-Arc	-0.62±0.29	-0.67±0.25	-0.38±0.20

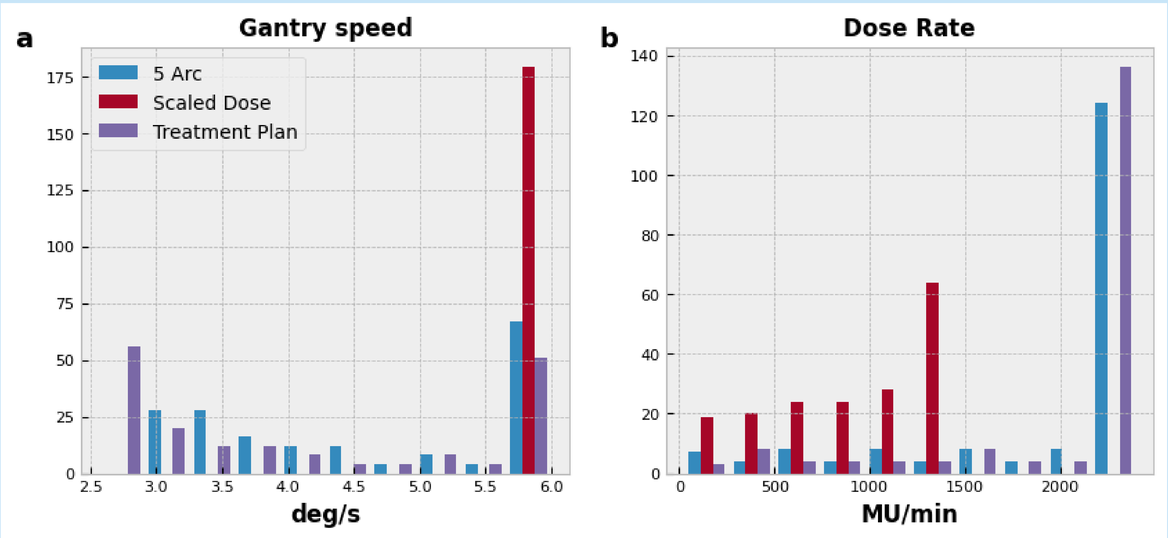

Figure 1. Histogram of (a) Gantry speed and (b) dose rate at all control points of one arc for 5 Arc and scaled dose QA plans and treatment plans.

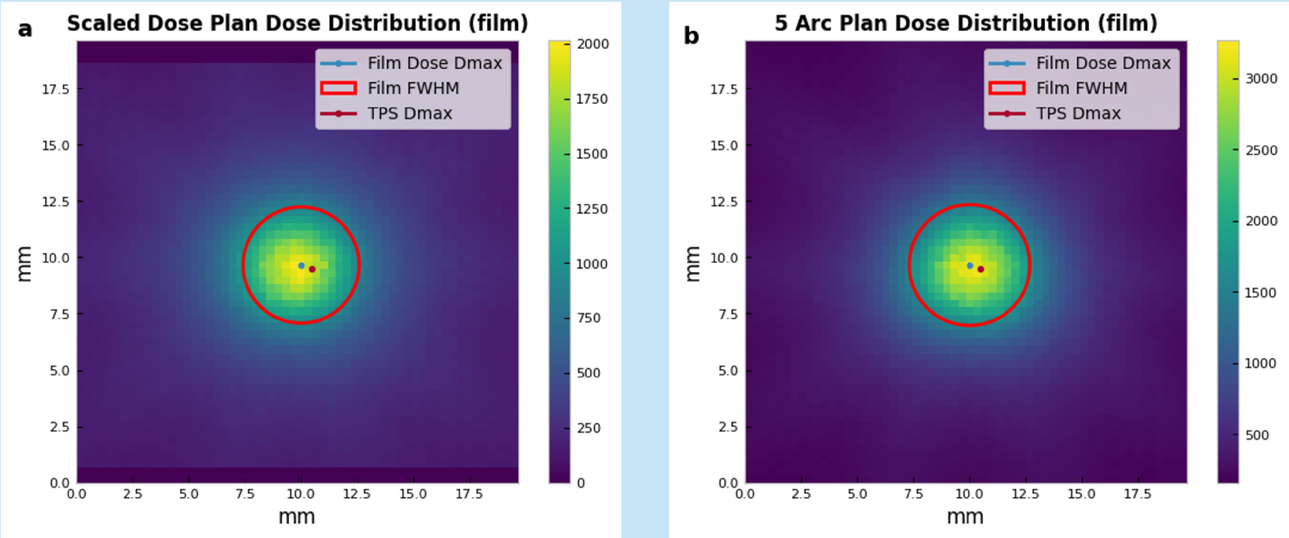

Figure 2. Figure 2: Example film dose maps for (a) scaled dose plan and (b) 5-arc dose plan.

DISCUSSION

Patient-specific QA is vital for trigeminal neuralgia plans that require a very small (5 mm FWHM) high dose (80 Gy) delivery. We evaluated two methods to fit the 80 Gy plans on commercially available films. Both QA methods resulted in similar dose spheres, with average FWHM values agreeing within error. The five-arc method results in a FWHM that is marginally closer to the exported dose planes from treatment plans.
As shown in Figure 1, the five-arc method produces verification plans that more mechanically similar to the clinical treatment plants.

Innovation and Impact

The proposed QA method allows for a more representative QA plan to be delivered, ensuring more robust QA for the technically challenging (TN) plans. By eliminating every second treatment arc as per our clinical protocol, the maximum dose is effectively scaled to fit on EBT-XD films with a comparatively small change to the gantry speed and dose rate during treatments. Ensuring the clinically modulated treatment plan is preserved will better represent the mechanical limitations of treatment.

CONCLUSIONS

Both QA plans agreed within uncertainties and with the 5mm sphere goal.
The five-arc QA plans keep the mechanical characteristics of the treatment delivery and should be favored for patient-specific TN QA

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REFERENCES

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