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Comparison of Tissue Sparing and Monitor Units for Multimet SRS Plans Using 70-90% Prescription Isodose Lines in Brainlab Elements 3.0

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INTRODUCTION

Modern treatment planning systems (TPS) have enabled optimization for linear accelerator-based cranial stereotactic radiosurgery (SRS) treating multiple brain metastases using dynamic conformal arcs and a single treatment isocenter. Because the volume of tissue receiving 12 Gy or more (V12) is linked to the probability of developing symptomatic necrosis [1], simultaneously balancing V12 and target coverage is critical to SRS plan quality.

In this work, we compare the effect of optimization using 70-90% prescription isodose lines on V12 and Monitor Units (MU) for cranial multi-met SRS plans.

METHOD

Using the Brainlab MultiMet Elements 3.0 TPS (Brainlab, Munich, Germany) on 12 SRS plans treated at our clinic on an Elekta Versa HD linear accelerator (Elekta, Stockholm, Sweden), we calculated V10, V12, V15, and monitor units (MU) for plans simultaneously treating 2-8 brain metastases.

$$V12 = V_{Brain,\,12Gy} - GTV$$

Eq 1. Definition of V12. We used V12 as equal to the volume of brain receiving at least 12 Gy, minus the gross tumor volume (GTV). V10 and V15 were defined accordingly.

Using "SRS Prescription" mode, we compared tissue sparing and MU for optimizations using 70%-90% prescription isodose lines in 5% increments.

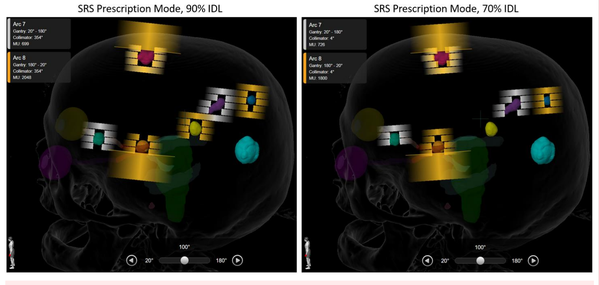
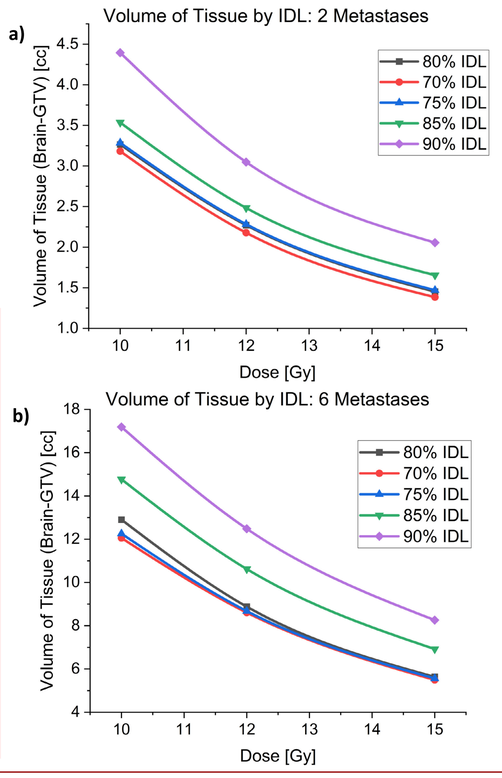


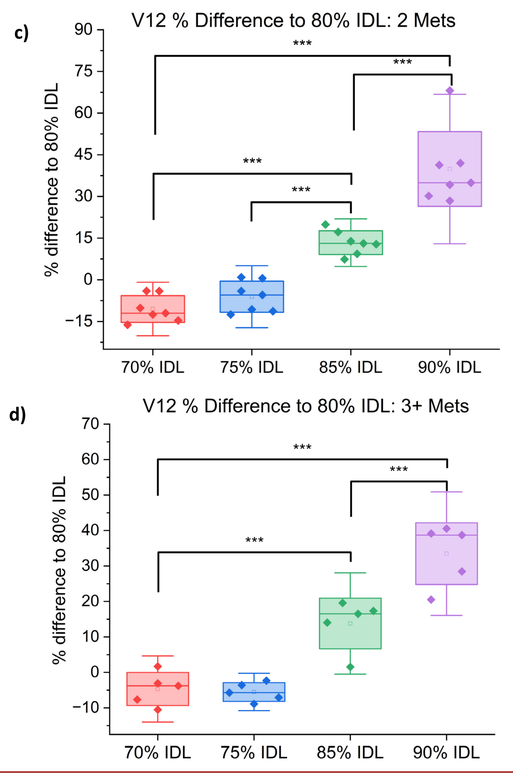
Fig 1. Beam's eye view comparison of optimization using the 90% prescription IDL (left) and 70% IDL (right). The use of greater negative margins (70% IDL) allows the TPS to close MLC apertures around each target in the arc.

RESULTS

Analysis performed for plans treating:

- 2 metastases (N=7)
- 4 metastases (N=2)
- 6 metastases (N=1)
- 7 metastases (N=1)
- 8 metastases (N=1)





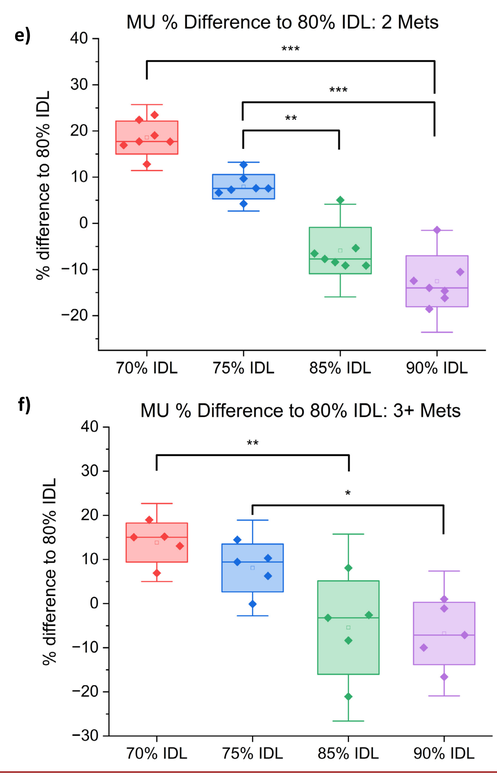


Fig. 2: a: Volume of tissue vs. dose for representative plan treating 2 brain metastases optimized using 70-90% IDLs. **b:** Volume of tissue vs. dose for representative plan treating 6 brain metastases optimized using 70-90% IDLs. **c:** V12 percent difference to 80% IDL for plans treating 2 mets. **d:** V12 percent difference to 80% IDL for plans treating 3+ mets. **e:** MU percent difference to 80% IDL for plans treating 2 mets. **f:** MU percent difference to 80% IDL for plans treating 3+ mets.

CONCLUSIONS

Results show that tissue sparing is affected by selection of the prescription isodose line. Relative to optimization at the 80% prescription isodose line, the optimization at the 75% or lower prescription isodose line significantly improved tissue sparing over the 85% or higher isodose lines ($p<0.001$), however, they also required greater treatment MU ($p<0.05$). The effects described seem to hold true regardless of the number of treated metastases.

Though there is significant benefit in using a prescription isodose line below 90%, results show little change in sparing below the 80% IDL (fig. 2 a,b). The 80% IDL was thus chosen as standard for our clinic, as it best balanced tissue sparing, hot spot, and treatment MU. Clinics implementing LINAC-based cranial SRS programs may consider similar analyses when developing their standard protocols.

REFERENCES

1. Minniti, G., Clarke, E., Lanzetta, G. et al. Stereotactic radiosurgery for brain metastases: analysis of outcome and risk of brain radionecrosis. Radiat Oncol 6, 48 (2011). https://doi.org/10.1186/1748-717X-6-48

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