

Minimising Body Dose in Stereotactic Radiosurgery

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Purpose

This study investigated how to reduce low-dose radiation scatter (Fig. 1) from stereotactic radiosurgery (SRS), which can increase the lifetime risk of secondary cancers, especially in younger patients. In response to recent NHS recommendations [2] limiting extracranial dose exposure, researchers evaluated the accuracy of Monte Carlo (MC) dose calculations in two treatment planning systems: Elekta Monaco and Brainlab Elements, using measurements from Thermoluminescent dosimeters and a Farmer chamber on a Varian Medical Systems TrueBeam linear accelerator.

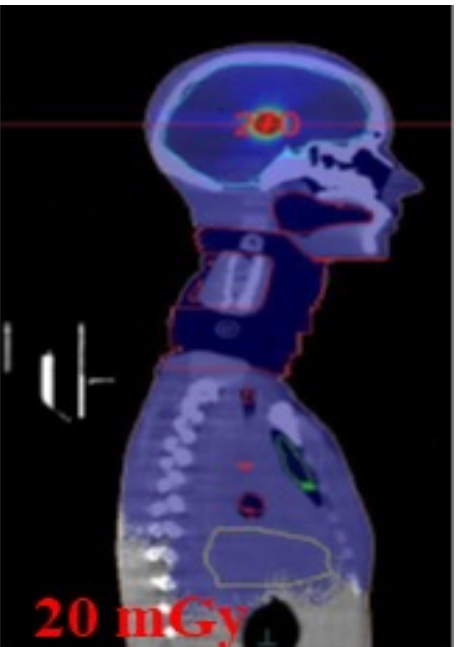


Fig.1 Low-dose scatter from SRS

Materials and Methods

The study found that low-dose predictions were reasonably accurate, with uncertainties of 28.1% for Monaco and 20.6% for Elements, improving on previously reported scatter-dose uncertainties. Both systems generally overestimated dose in low-dose regions, though accuracy was partly limited by TPS dose printout precision.

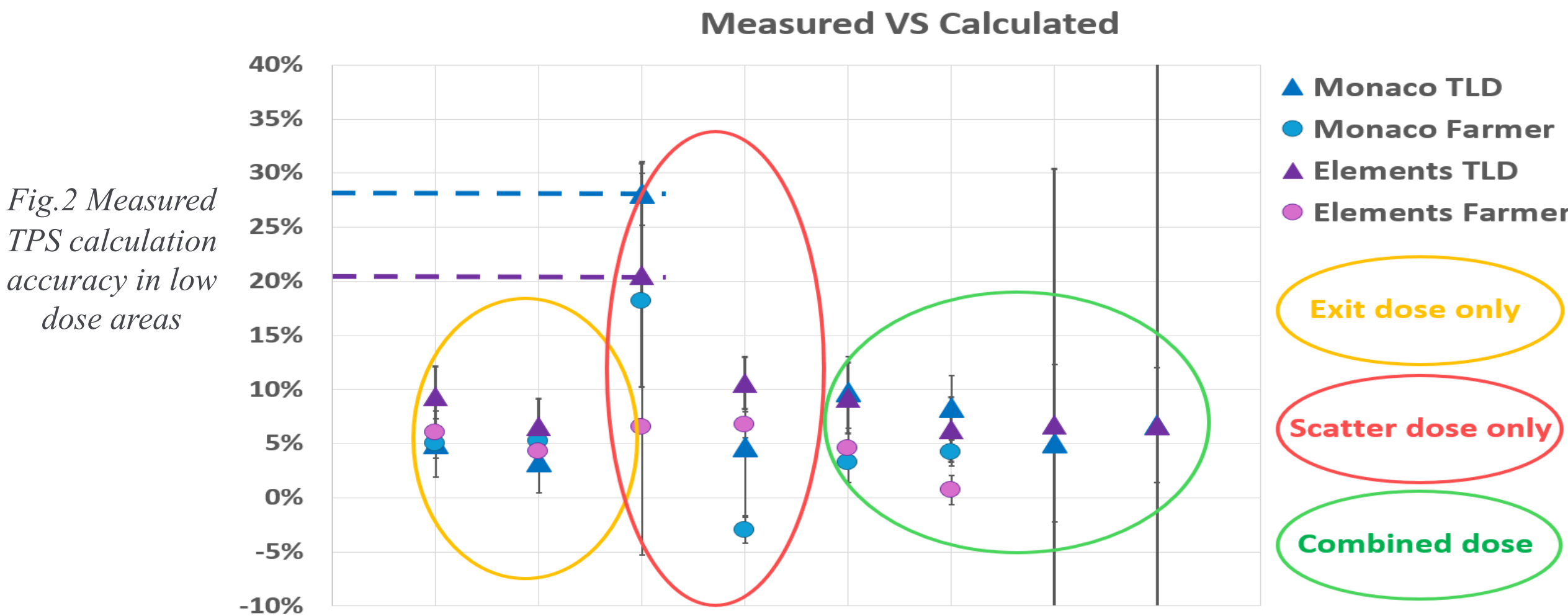


Fig.2 Measured TPS calculation accuracy in low dose areas

References:

- [1] Paddick I, et al. Extracranial dose and the risk of radiation-induced malignancy after intracranial stereotactic radiosurgery: is it time to establish a therapeutic reference level? *Acta Neurochir (Wien)*. 2021;163(4):971-979.
- [2] NHS service specification: Stereotactic Radiosurgery and Stereotactic Radiotherapy (Intracranial) (All Ages), <https://www.england.nhs.uk/publication/service-srs-intracranial-all-ages/>
- [3] Sánchez-Nieto B, et al. Study of out-of-field dose in photon radiotherapy: A commercial treatment planning system versus measurements and Monte Carlo simulations. *Med Phys*. 2020;47(9):4616-4625.

Results

The study found that low-dose predictions were reasonably accurate, with uncertainties of 28.1% for Monaco and 20.6% for Elements (Fig.2), improving on previously reported [3] scatter-dose uncertainties. Both systems generally overestimated dose in low-dose regions, though accuracy was partly limited by TPS dose printout precision. The team also tested 15 clinically relevant SRS treatment plans using optimisation strategies such as adjusting arc table angles and incorporating special organ-at-risk constraints (Fig.3). These methods successfully kept body dose 30 cm from the target below the NHS-recommended [2] 20 mGy limit while maintaining clinically acceptable and deliverable treatment quality.

Conclusion

Overall, the study demonstrates that accurately modelled MC algorithms in Monaco and Elements can reliably estimate body scatter dose in SRS, and that practical planning techniques can substantially reduce unnecessary patient radiation exposure without compromising treatment effectiveness (Fig.3). The findings support wider adoption of dose-minimisation strategies in clinical SRS practice.

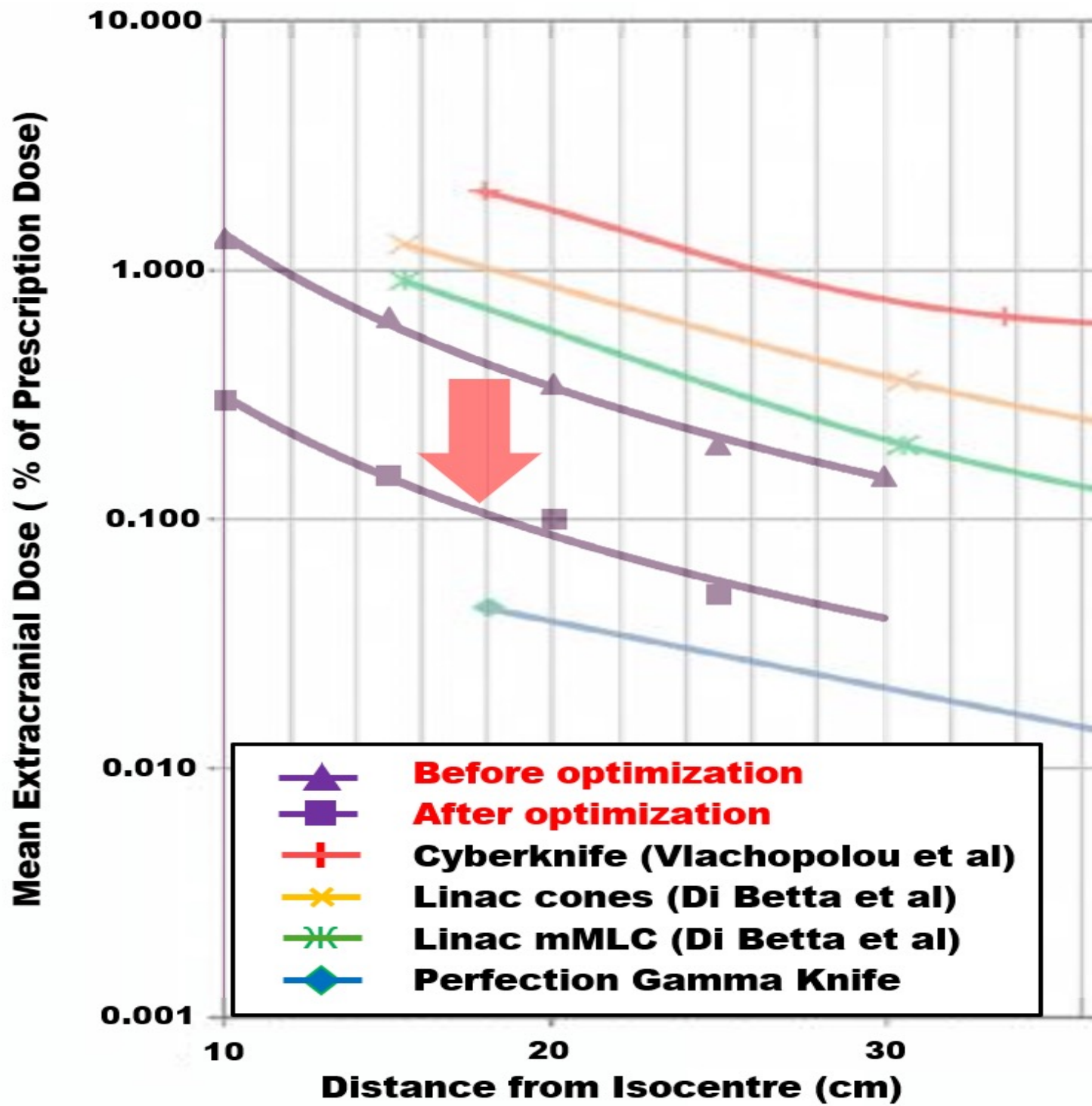


Fig.3 Comparison of Extracranial Doses for Different Radiosurgery units [1] with our improvement for Linac SRS