Health New Zealand
Te Whatu Ora

MINIMISING BODY DOSE IN STEREOTACTIC RADIOSURGERY

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Introduction

Low-dose body scatter from SRS treatment (Fig. 1) can increase the lifetime risk of secondary cancer [1]. Extra care must be taken to reduce such risk. The latest NHS SRS service specification sets extracranial dose limits for patients with the highest lifetime risk [2]. This study evaluates how to implement these recommendations in clinical practice and minimise the patient dose from SRS.

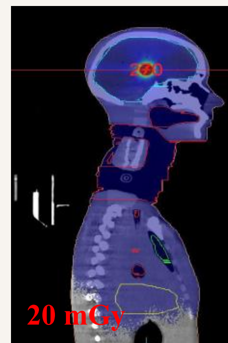

Fig.1 Low-dose scatter from SRS

Method

The low-dose calculation accuracy of the Monte Carlo (MC) algorithm for the Varian TrueBeam linear accelerator was validated for two treatment planning systems (TPS): Monaco (Elekta) and Elements (Brainlab), using Thermoluminescent Dosimeters (TLD) and a Farmer chamber.

Clinically relevant treatment plans with varying target sizes and locations were optimised on the phantom using non-coplanar arcs and exit-dose minimisation techniques.

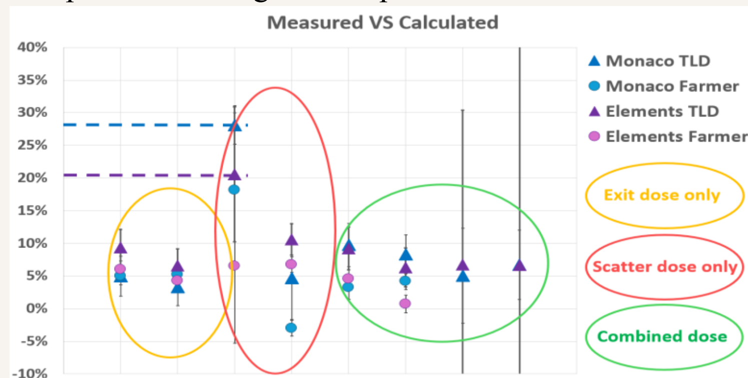

Fig.2 Measured TPS calculation accuracy in low-dose areas

Results

For the present beam models, the dose prediction at the distance from the target is accurate within 28.1% for Monaco and 20.6% for Elements (Fig.2), outperforming previously reported scatter dose uncertainties [3]. It was found that the planning system is generally overestimating the dose in the low-dose region. The calculation accuracy was limited by the TPS dose printout limitation, which can be further improved.

Options for reducing the dose to the body were investigated. These include optimising the arcs table angle and using the special OARs for optimisation. Fifteen SRS plans emulated in Elements and remained clinically acceptable and deliverable, with doses at the patient's body at 30 cm from the target kept below 20 mGy in accordance with the NHS recommendations [2].

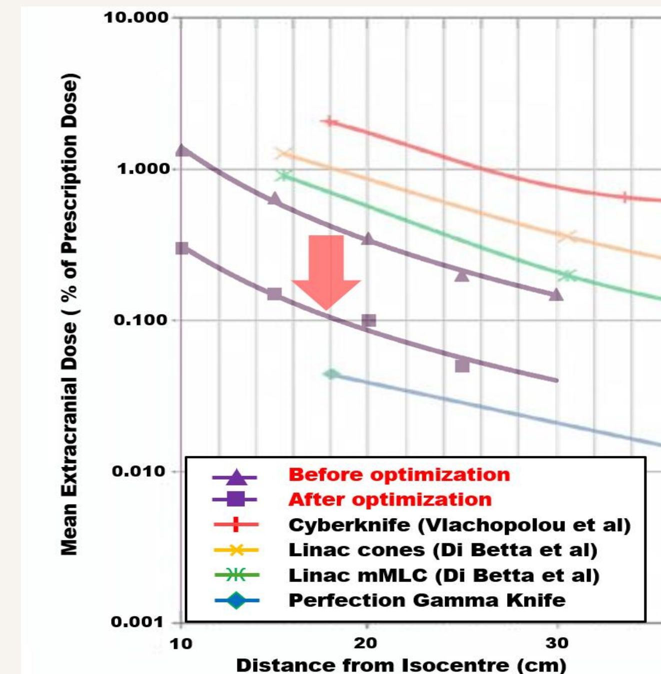

Fig.3 Comparison of Extracranial Doses for Different Radiosurgery units [1] with our improvement for Linac SRS (using MLC)

Conclusion

Elements and Monaco MC algorithms with a properly modelled beam allow assessment of extracranial dose from SRS to comply with the latest recommendations. Clinically viable SRS plans for C-arm linacs can be optimised to substantially reduce body dose without compromising treatment quality (Fig.3). Given documented scatter-induced cancer risks, especially in younger patients, such dose-minimisation strategies are clinically important and warrant wider adoption.

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.