Applicability of the Conformity Gradient Index to Evaluate Single Isocenter Multi Target SRS Plan Quality

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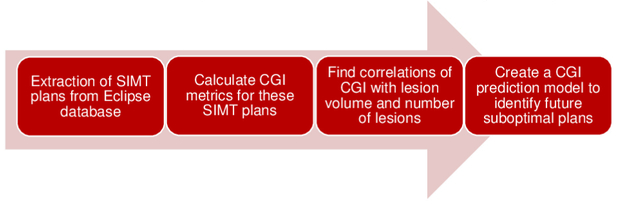
Introduction

The Conformity/ Gradient Index (CGI) is a simple tool used to evaluate single target SRS plan quality. It is characterized by three data points: the sum of target volumes (TV), prescription isodose volume and 50% isodose volume. Prior studies applied the CGI metric to single target SRS plans, and this work studies its applicability to SIMT plans, where multiple intracranial lesions are treated by the same arc using a single isocenter.

Purpose

The purpose of this work was to retrospectively evaluate institutional SIMT plans to build a CGI prediction model and identify suboptimal SIMT plans.



Methods

CGI calculation

Conformity score: $\mathrm{CGI_C} = 100\left(\frac{\text{Target Volume}}{\text{Prescription Isodose Volume}}\right)$,

Gradient score: $\mathrm{CGI_G} = 100 - \{100[(\mathrm{R_{Eff,50\%Rx}} - \mathrm{R_{Eff,Rx}}) - 0.3\mathrm{cm}]\}$,

where $\mathrm{R_{Eff}} = \sqrt[3]{\frac{3V}{4\pi}}$, $\mathrm{R_{Eff,50\%Rx}}$ and $\mathrm{R_{Eff,Rx}}$ are the radii of the 50% isodose and prescription isodose lines.

$$\mathbf{CGI} = (\boldsymbol{CGI_C} + \boldsymbol{CGI_G})/2$$

CGI was calculated for 477 SIMT plans. Small negative linear associations of the CGI with target volume and number of targets were found.

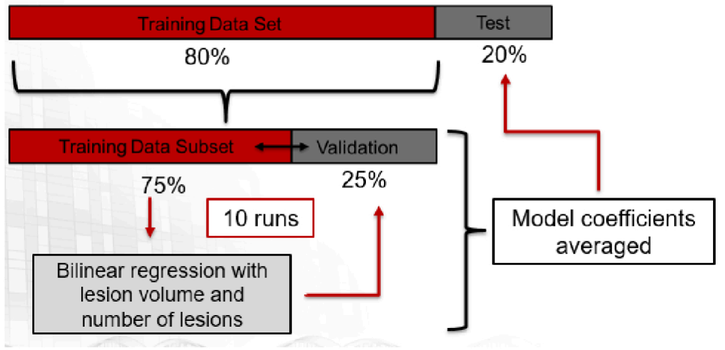


Fig 1. Schematic to build the CGI prediction model by reshuffling the data in training and validation sets.

Results

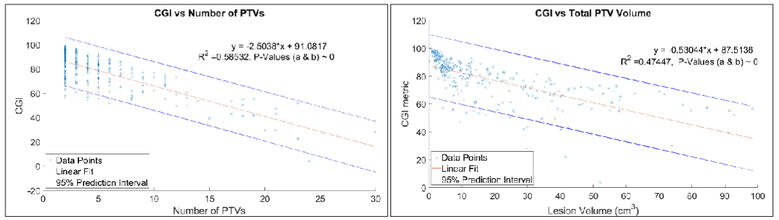
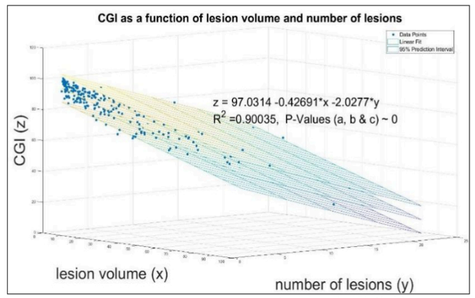
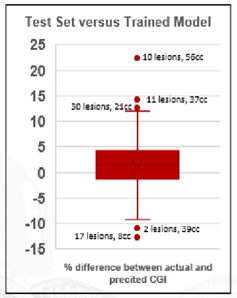


Fig 2. Linear regression of CGI With target volume and number of targets showing a significant linear correlations (R^2 = 0.47, 0.58, p-values ~ 0)

Results

CGI values ranged from 22.5 (23 lesions, 42cc volume) to 99.2 (2 lesions, 1.1cc volume), with an average score of 78.6 ± 18.2.





In Fig. 3, The bivariate regression model shows CGI linearly decreases with increasing number of targets and total target volume (p-value = 0, α = 0.05, R^2=0.9). The average percent difference from the test dataset's calculated CGI to the predicted CGI was 1.31 ± 5.28. Most outliers correspond to plans with high lesion volume/ lesion number.

Conclusions

This study shows the potential applicability of the CGI to SIMT plan evaluation. A prediction model for SIMT CGI using the target volume and number of targets was built. Suboptimal plans can be identified if the CGI differs from the predicted CGI.

References

1] *Wagner et al. Int. J. Radiation Oncology Biol. Phys., Vol. 57, No. 4, pp. 1141-1149, 2003.*
[2] *A. Sandu, S. Thompson, A. Ayan, and N. Gupta, Medical Physics, Vol. 43, p. 3603, June 2016*