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EASTERN TIME [GMT-4]

A Novel Conformity Index to Minimize Volume Effects: Application in SRS/SRT

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INTRODUCTION

- ✓ ***In order to assess the quality of SRS plans and assess for the amount of irradiated normal tissue multiple indices have been developed.[1]***
  - conformity index (CI)
  - heterogeneity index (HI)
  - gradient index (GI)
- ✓ ***The indices are defined based on the volume-dependent parameters and may be inaccurate predictors of lesion control and toxicity.***

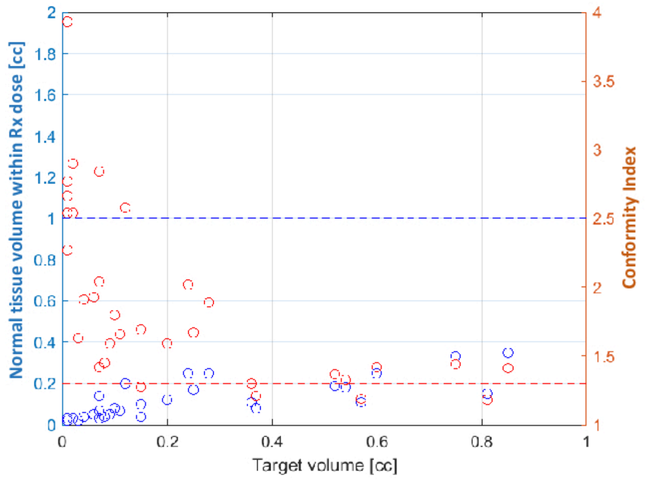

Figure 1. The relationship between conformity index (right y-axis, red circles) and normal tissue volume within the prescription isodose volume (left y-axis, blue circles) for the target volume <= 1cc. Although the normal tissue volumes are < 1cc in all test cases, the conformity indices are > 1.3 for 29 cases of 33.

AIM

- ✓ ***Develop a volume-independent conformity metric called the Gaussian Weighted Conformity Index (GWCI)***
  - *For evaluating the quality of stereotactic radiosurgery/ radiotherapy (SRS/SRT) plans for* ***small brain tumors***

METHOD

- ✓ *The GWCI is calculated by the following steps:*
  1) *calculating signed bi-directional distance[2] between the prescription isodose line and the target contour (positive distance represents under-dose, Fig. 2)*
  2) *assigning different weight to Gaussian functions which has heights one and center zero, depending on the under- and over-dose[3] (Gaussian weighting)*
  3) *multiplying the distance and the Gaussian weighting on each point*
  4) *averaging the results of step 3*
- ✓ *The GWCI can penalize tumor under-/over-dosing by changing the Gaussian weightings.*
  - *We penalizes tumor under-dosing one to five times more heavily than the prescription isodose falling outside the tumor (over-dose).*
  - *Five weighting combinations were tested for finding the optimal weighting values.*
- ✓ *A total of 40 targets from 18 patients received Gamma-knife SRS/SRT were chronically selected to test the concept. Their DICOM RT dose and structure files were exported from the planning system. New conformity indices (NCI)[1] were also calculated to evaluate the proposed GWCIs.*

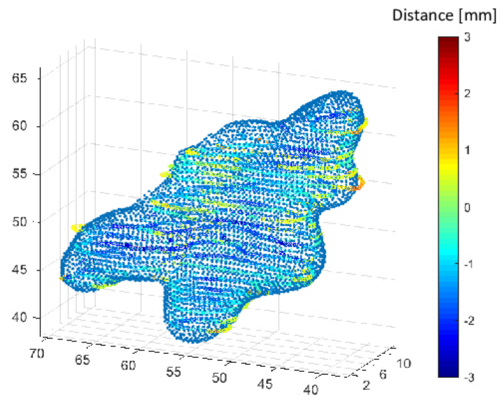

Figure 2. The signed bi-directional distance between prescription isodose surface (PIS) and target contours. Positive distance indicated when the target contour located outside of the PIS and vice versa.

RESULTS

- ✓ *Among 5 test weighting combinations, the penalizing the under-dose twice than over-dose showed optimal range of GWCIs and its average ± standard deviation is 0.991±0.003. (Fig. 3)*
- ✓ *A GWCI of 0.985 may be used as a volume-independent cutoff for plan conformity when the under-dose penalized twice than over-dose. For target volumes < 1 cc, the current CI values showed large volume-dependency; thus for small tumors covered with a slightly larger isodose cloud, a disproportionately large CI may be obtained. However, the proposed GWCI showed minimal volume-dependency. In the test cases, targets with volume less than 1cc had normal tissue volumes which received prescription doses less than1 cc. (Fig. 4)*

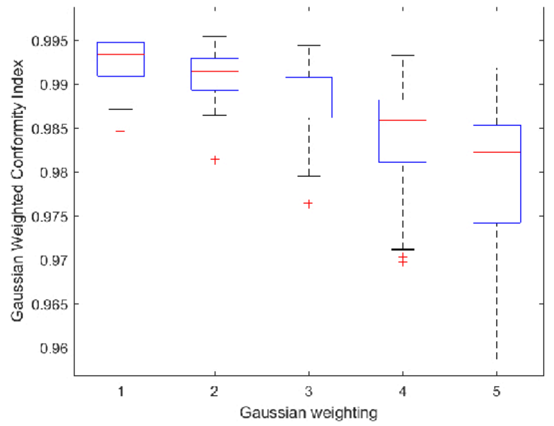

Figure 3. The boxplot of Gaussian Weighting Conformity Index with 5 different weighting factors. From left to right, the under-dose penalized 1 to 5 times than the over-dose.

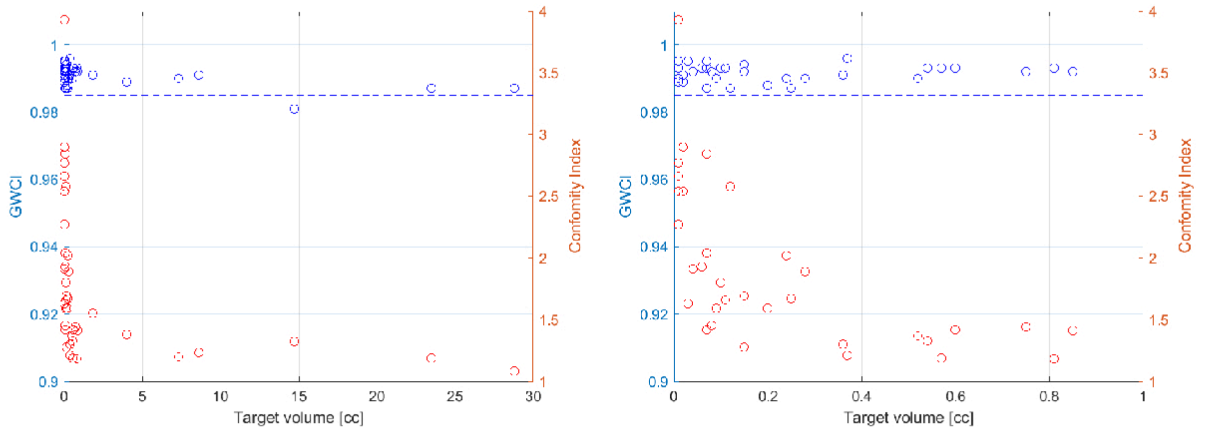

Figure 4. The proposed GWCI (left y-axis, blue circles) and the current conformity index (CI, right y-axis, red circles) sorted by target volume. The blue dash line and red dash line represent GWCI=0.985 and CI=1.3, respectively.

CONCLUSIONS

- ✓ *Limitations of current conformity indices become apparent when applied to radiosurgery treatment plans of target volumes < 1cc.*
- ✓ *A GWCI tool was successfully developed which can be used to accurately score the quality of an individual treatment plan while eliminating small volume effects.*

REFERENCES

1. ***M. Torrens et al.,*** Standardization of terminology in stereotactic radiosurgery: Report from the standardization committee of the international Leksell Gamma Knife Society. *J Neurosurg (Suppl 2) 2014;121:2-15*
2. ***H. Kim et al.***, Bi-directional local distance measure for comparing segmentations. *Medical physics. 2012;39(11):6779-6790*
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