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Feasibility of 3-Field IMPT for Large-Volume Skin Cancer Using Custom Bolus and LET-Weighted Dose Assessment

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Objective

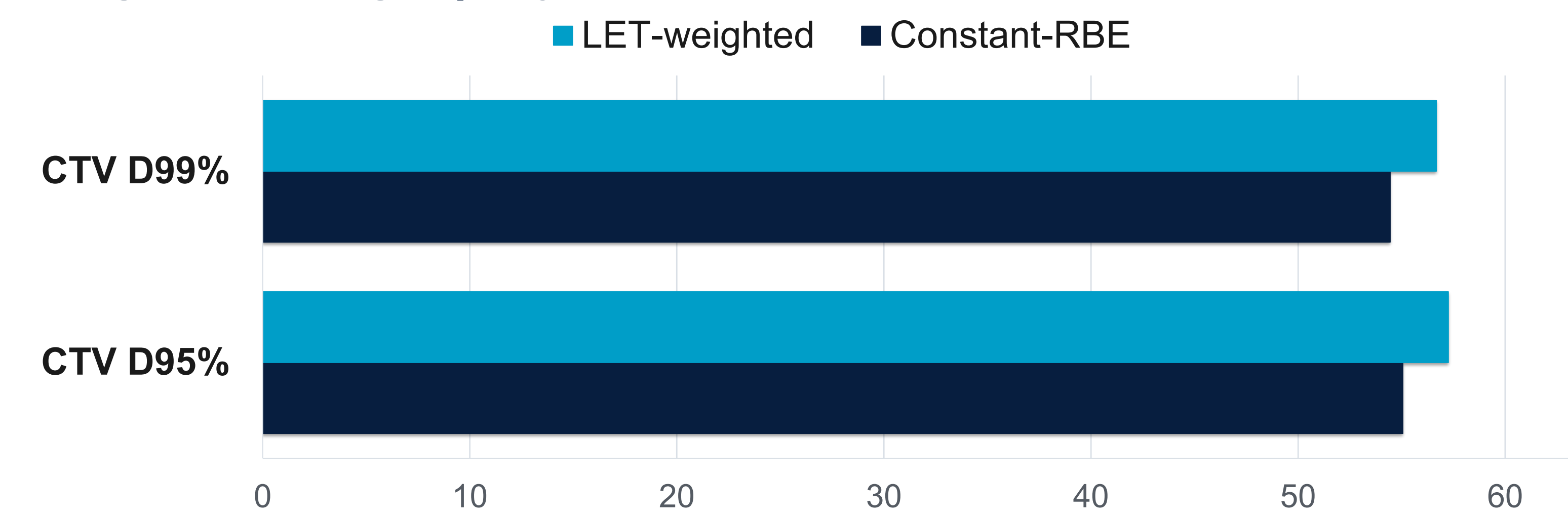
To evaluate the feasibility of treating a large superficial skin cancer target with a 3-field static intensity modulated proton therapy (IMPT) technique and to assess the potential impact of elevated LET in high-dose regions.

Methods

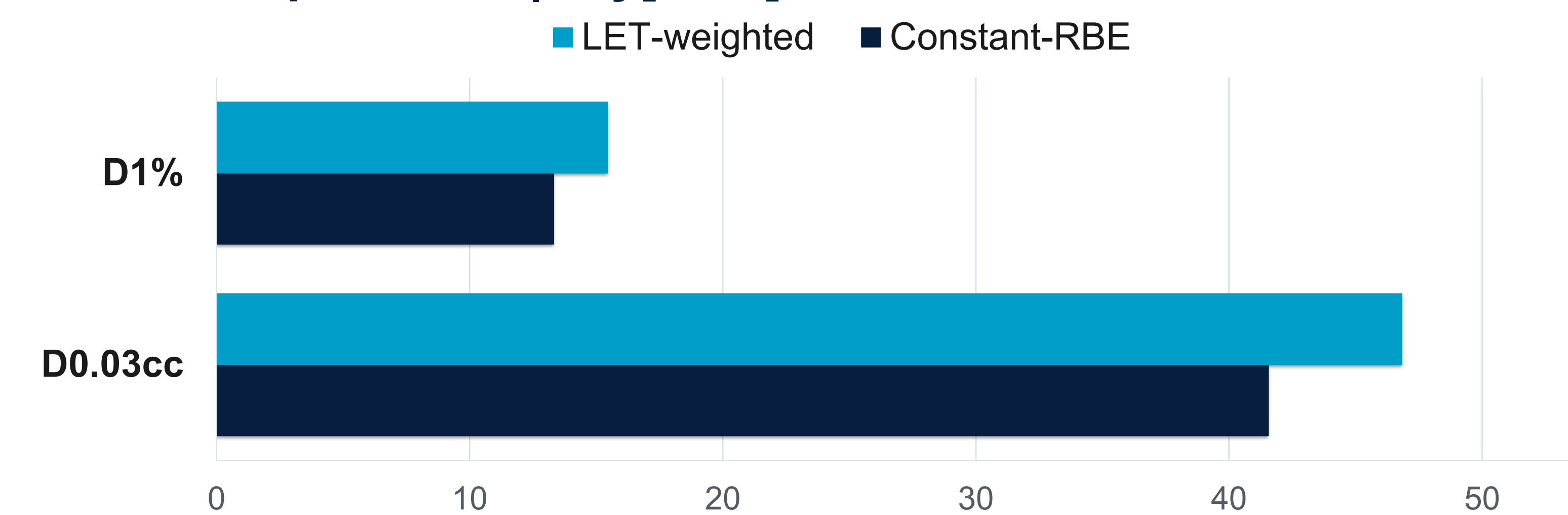
- ❑ A retrospective replanning study was performed on a previously treated helical tomotherapy case (55 Gy in 20 fractions).
- ❑ A new 3-field IMPT robustly optimized plan was generated to cover the large target volume using a patient-specific bolus and a 4-cm WET range shifter.
- ❑ The same IMPT plan was evaluated in two dose reporting modes: (1) nominal constant-RBE dose (RBE=1.1), and (2) LET-weighted dose calculated using a linear model with $k=0.052$, where RBE (and RBE-weighted dose) increases linearly with dose-averaged LET (LET_d).
- ❑ Plan evaluation focused on target coverage and homogeneity index, $HI=(D2-D98)/D50$, and brain V5Gy, D0.03cc and D1%.
- ❑ Additional nearby OARs (brainstem, optic apparatus, lenses, lacrimal glands, cochleae) were reviewed.

Results

Target coverage | Gy[RBE]



Brain hotspot dose | Gy[RBE]



Interpretation

LET weighting increased CTV dose and brain near-maximum dose; the low-dose bath and other adjacent OAR doses remained essentially unchanged.

Key findings

LET-weighted vs constant-RBE

+4.0%

CTV D95%

55.06 → 57.26 Gy[RBE]

+12.7%

Brain D0.03cc

41.55 → 46.82 Gy[RBE]

+16.0%

Brain D1%

13.32 → 15.45 Gy[RBE]

Homogeneity index

0.037 → 0.088

less homogeneous

Brain V5Gy

12.49% → 12.47%

low-dose bath stable

Conclusion

- ❑ Three-field static IMPT using a custom bolus and a 4-cm WET range shifter is feasible for large-volume skin cancer, achieving clinically acceptable target coverage with low brain dose.
- ❑ However, LET-weighted evaluation shows increased biologic hotspots and higher brain near-maximum dose, highlighting the need to explicitly assess high-LET/high-dose regions in the brain before broader clinical adoption.

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