

# A Knowledge-Based Planning Model for Proton-Based CSI

Robert Kaderka<sup>1</sup>, Morgan E Freret<sup>1</sup>, Michael Butkus<sup>1</sup>

<sup>1</sup>University of Miami Miller School of Medicine, Radiation Oncology, Miami, USA

## Purpose

- **Leptomeningeal metastases** (LM), the spread of cancer to the cerebrospinal fluid, is a devastating manifestation of cancer.
- Without treatment, LM survival is limited to months.
- A recent randomized phase II study demonstrated that **proton Craniospinal Irradiation** (pCSI) more than doubles survival in patients with LM from breast and lung cancer.
- LM progresses rapidly requiring fast treatment.
- Proton treatment planning is complex and time-consuming hindering the fast initiation of pCSI.
- In this study, we develop a **knowledge-based planning** (KBP) model to automate plan optimization and thus enable faster treatment initiation.

## Materials and Methods

- A KBP model was developed using 33 patients with LM who previously received 30Gy(RBE) in 10 fractions.
- KBP optimization objectives were iteratively tuned until plan quality met clinical standards.
- Model performance was validated using an independent testing cohort of 10 LM pCSI patients.
- KBP plans were generated in two steps with an initial run of the model, and a continued run with an added Body Dmax objective.
- Both manual and KBP plans were normalized to same target coverage for comparison.
- Target and Organ-at-Risk **Dose-volume histogram** (DVH) parameters were compared.
- Evaluated KBP plan optimization times with a stopwatch.

## Results

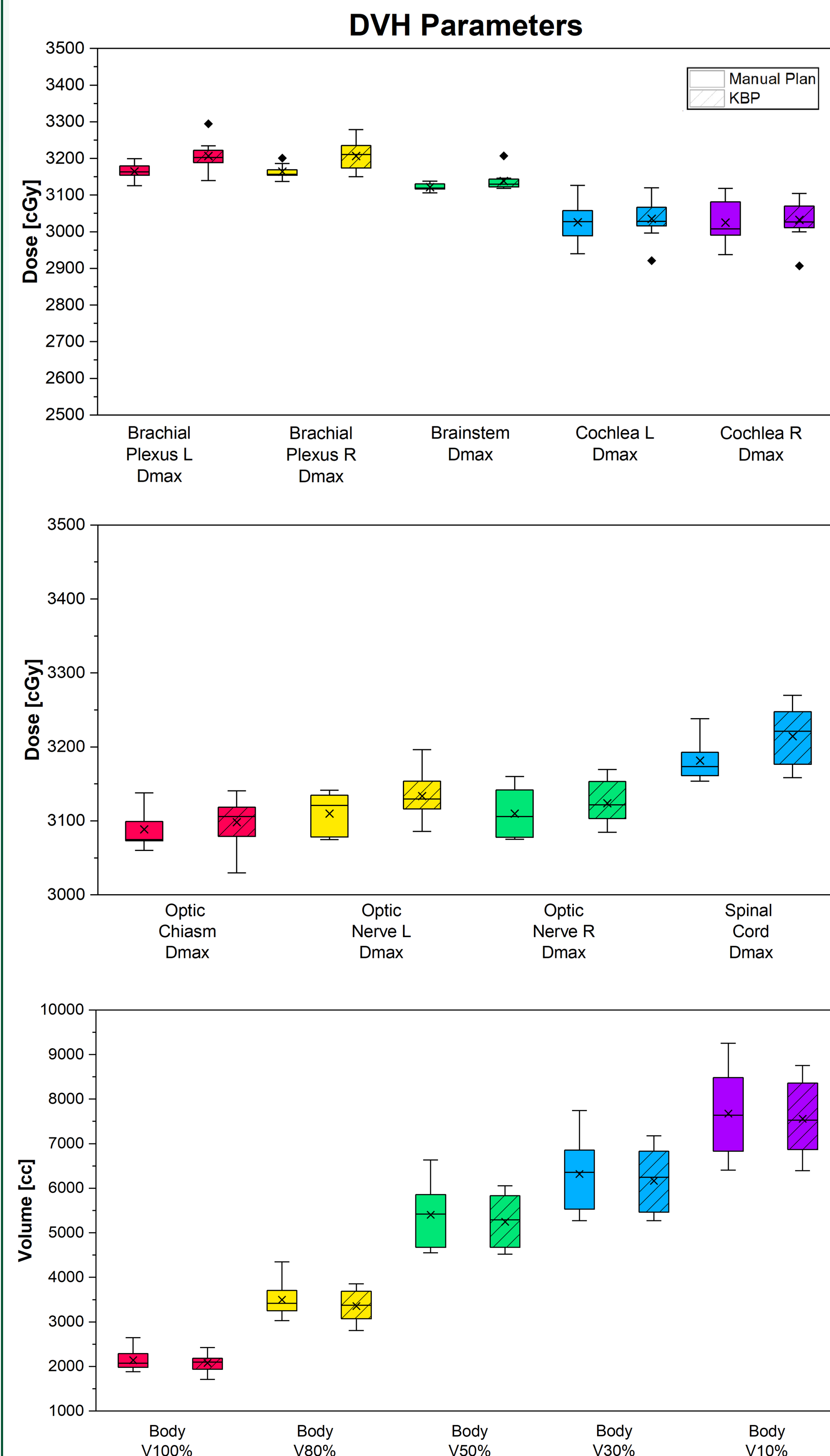


Figure: Excerpt of DVH parameters across the 10-patient validation cohort for the manual planners (left of each pair) and KBP plans (right of each pair).

## Results (continued)

- Initial KBP plan optimization required around **20 minutes** with minimal human intervention.
- A subsequent optimization reducing plan hot spots took an additional **8 minutes**.
- KBP plans were normalized to same target coverage (V100%=98%).
- KBP plans increased CTV D1% slightly from 104.7%±0.2% (mean±standard deviation) to 105.8±1.1%.
- Across 37 organs-at-risk, average differences between manual and KBP plans were <1 Gy.
- Slight reduction in integral body dose in KBP plans.

## Conclusions

- While some DVH parameters were slightly worse, KBP plans were clinically acceptable.
- Plan optimization time reduced substantially, allowing for faster treatment initiation of pCSI for LM.
- Future work will investigate automating beam angle setup to further improve workflow efficiency.
- KBP model is now being used clinically to allow for fast turnaround of these urgent cases.

### Contact Information

rkaderka@med.miami.edu