Investigation of the Eclipse Auto-Feather Feature for VMAT Craniospinal Irradiation Treatment Plans

J Kunz, A Paxton, V Sarkar, G Nelson, R Price, B Salter

Huntsman Cancer Institute at the University of Utah | Salt Lake City, UT

Introduction

The Eclipse v15.5 TPS has an auto-feathering feature that allows the co-optimization of two or more isocenters in the same plan. This feature benefits long targets, such a craniospinal irradiation (CSI), by lengthening the dose gradient region to be robust against longitudinal setup uncertainties

This study investigates how and what parameters can be fine-tuned in order to optimize the dose gradient in VMAT CSI plans where Varian's auto-feathering feature is used. By understanding how isocenter locations and jaw settings affect the auto-feathering algorithm, VMAT CSI plans can be improved to obtain a desired length of dose gradient region to reduce hot/cold spots during treatment due to setup uncertainties.

Methods

Patients who had previously received VMAT CSIs were retrospectively re-planned. Re-plans systematically varied the isocenter separation (in the craniocaudal direction; see figure 1) and jaw settings (jaw opening, as well as jaw tracking) in order to determine the effect each of these parameters had on the auto-feathered dose gradient region. Known longitudinal setup errors were simulated within the TPS to evaluate plan robustness in the presence of setup uncertainties.

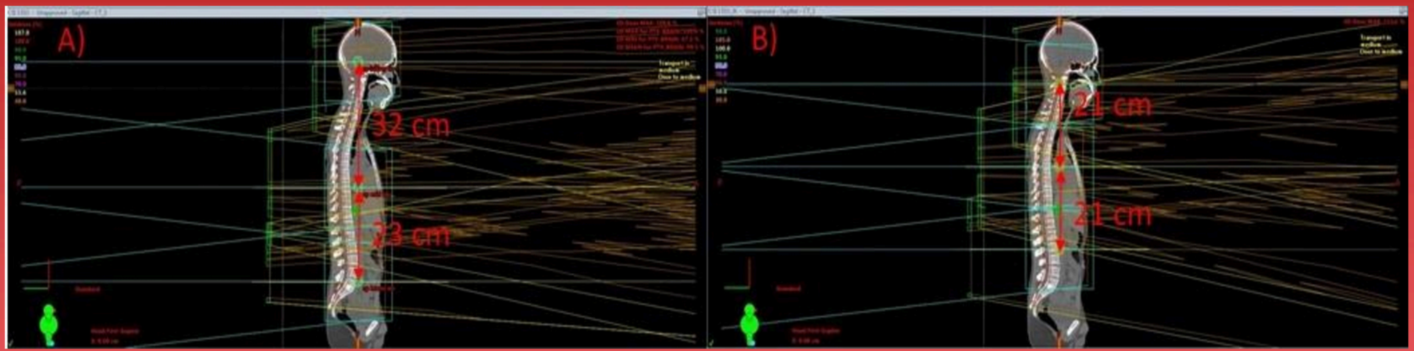

Figure 1: Sagittal view showing relative isocenter locations for the original plan (A) and the adjusted plan (B) where isocenter placement was adjusted and jaw settings modified to increase overlap region.

Results

Optimizing isocenter location to allow for greater field overlap increased the gradient region (decreased gradient slope). In a representative case, the gradient region went from 4.5 cm to 15 cm by placing isocenters in a way such that the full allowable jaw opening was utilized, while decreasing jaw openings always lead to decreased gradient regions (steeper gradient slope).

For each case investigated, removing jaw tracking increased the gradient region by 1-6 cm compared to plans with jaw tracking (see figure 2). Plans with more gently sloping dose gradients in the overlap region were more robust to simulated patient setup uncertainties (see figure 3).

Figure 2:Dose profiles in the dose gradient region between the upper spine isocenter and the brain isocenter for a 3-iso VMAT CSI plan. The original plan had a steep dose gradient that had an overlap of approximately 4.5 cm (A); whereas, the adjusted plan shows more gradual dose gradients over 15 cm (B) and 17 cm (C) overlap regions, with and without jaw tracking, respectively.

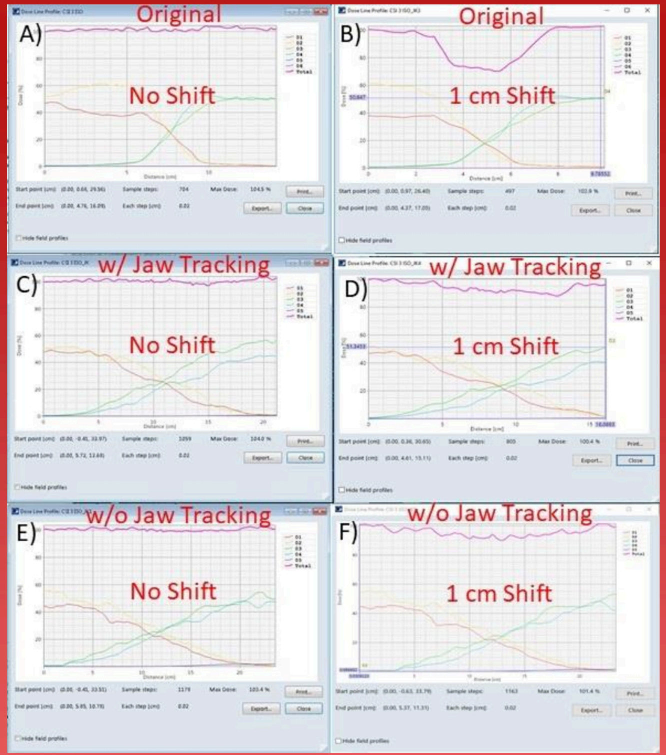

Figure 3: Dose profiles in the dose gradient region between the upper spine isocenter and the brain isocenter for a 3-iso VMAT CSI plan for original plan (A), gradient-adjusted plan, w/ jaw tracking (C), gradient-adjusted plan w/o jaw tracking (E), and with simulated 1 cm inferior shift in patient setup (B, D, and F). Note the much improved robustness of optimized plan D and F.

Conclusion

Increasing the area of the jaw overlap region allows the auto-feathering function to provide longer, more gently sloping dose gradients in VMAT CSI treatment plans which, subsequently, reduces sensitivity to hot/cold spots during treatment due to setup uncertainties. Optimizing plans without the use of jaw tracking provided more gently sloping, robust dose gradients versus plans optimized with jaw tracking enabled.