COMPARATIVE PLAN ANALYSIS FOR A COMPLEX SUPRAORBITAL SQUAMOUS CELL CARCINOMA USING 3D PRINTED MODULATED ELECTRON BOLUS

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Purpose:

To determine whether the use of electron therapy dosimetry using a novel modulated electron bolus (MEB) leads to improved plan metrics compared to standard techniques for a complicated supraorbital squamous cell carcinoma.

Methods:

- 6 plans were generated from CT simulation images (Figure 1 A-F).
- Boluses were generated by the Eclipse planning system, except for MEB created by the 3DBolus 2.0 software (Adaptiiv Medical Systems). This allows optimization of the MEB shape to achieve conformity, and optionally, reduction of hot-spots in the distributions (Basaric, 2019).
- Plans were normalized to achieve 90% dose, covering 98% of the planning target volume (PTV)

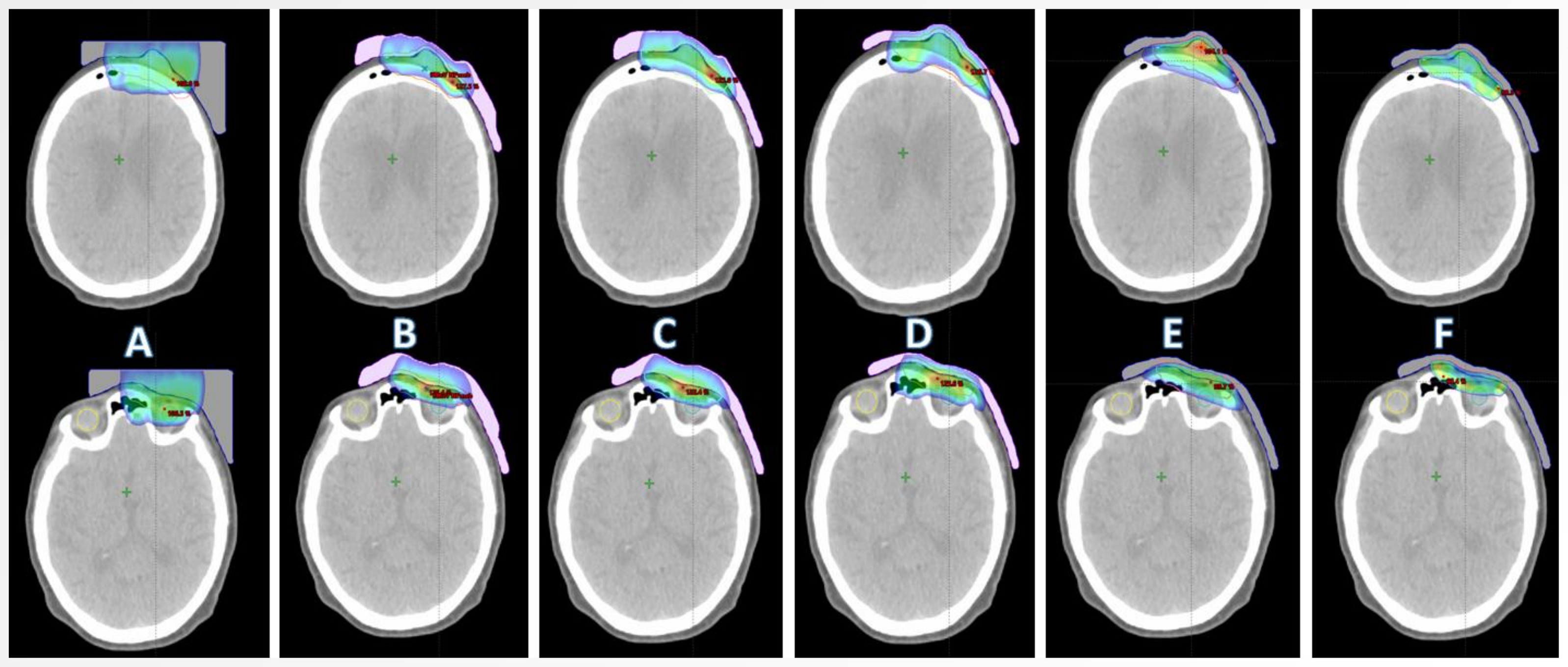

Fig. 1: Bolus structures and 90% dose wash for A) direct electron block bolus B) MEB with no hotspot correction C) MEB with hotspot correction D) appositional electron with 0.5 cm bolus E) tangent photons with 0.5 cm bolus F) VMAT with 0.5 cm bolus

- Evaluation metrics were quantified:
  - Max dose (D_{max} to 0.1 cc) to the ipsilateral lens and brain
  - Volume of brain receiving 80%, 50% and 20% of the prescription dose (V80, V50, V20)
  - Homogeneity index (HI) defined as:

(DmaxPTV-DRx PTV)/DmeanPTV

Results:

Ipsilateral lens (Figure 2)

- VMAT yielded the lowest D_{max} (78.4%), and appositional electron the highest (103.9 %)
- Between the MEB plans, using the hotspot correction increased the Dmax of the ipsilateral lens from 91% to 94.35%

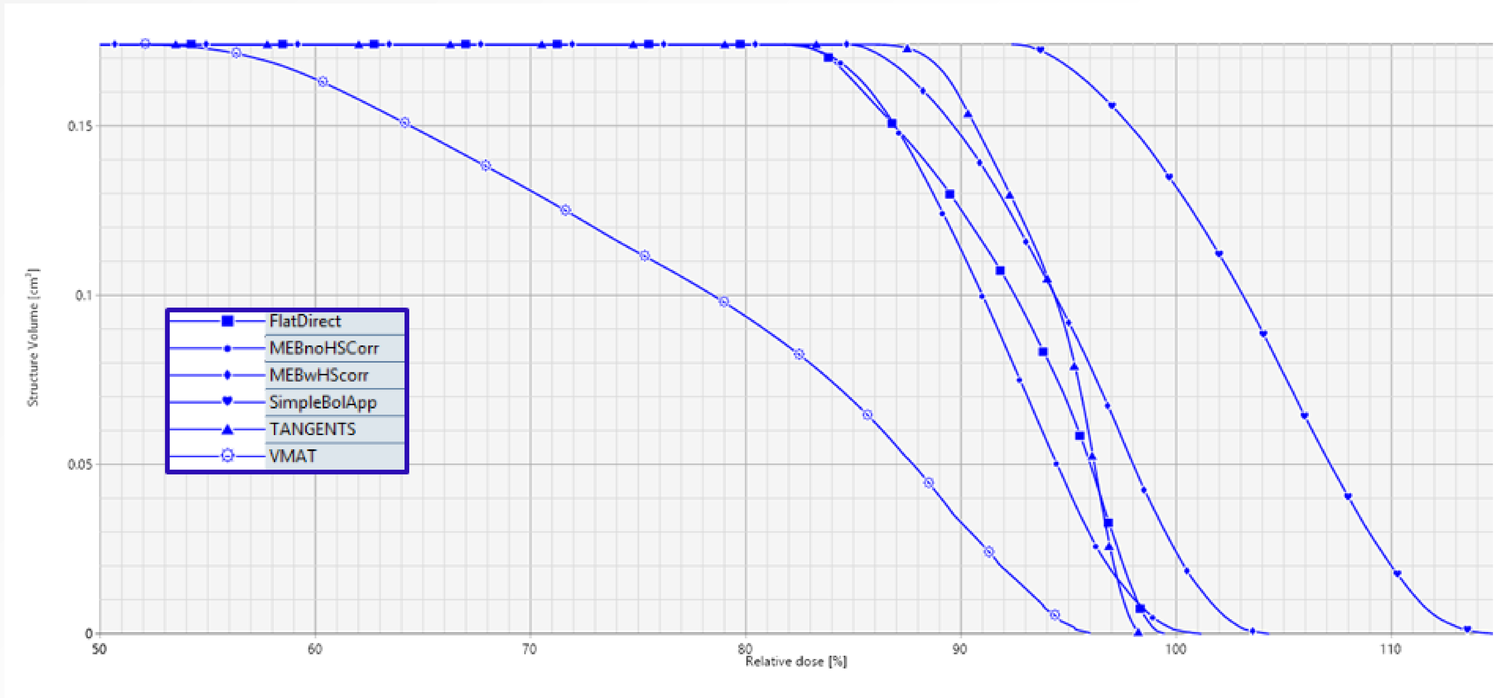

Fig. 2: Dose Volume Histograms (DVH) for the ipsilateral lens

Normal Brain (Figure 3)

- MEB without and with hotspot correction gave the lowest Dmax for normal brain (75.9%/77.8%). Dmax was greatest for direct electrons with appositional bolus (112.9%)
- MEB plan with no hotspot correction yielded the lowest V80 (0.02 cc) and V50 (4.26 cc). The tangential plan resulted in the lowest V20 to normal brain (8.86 cc), followed by MEB without/with hotspot correction (15.84/20.27 cc), with VMAT the highest (93.44 cc)

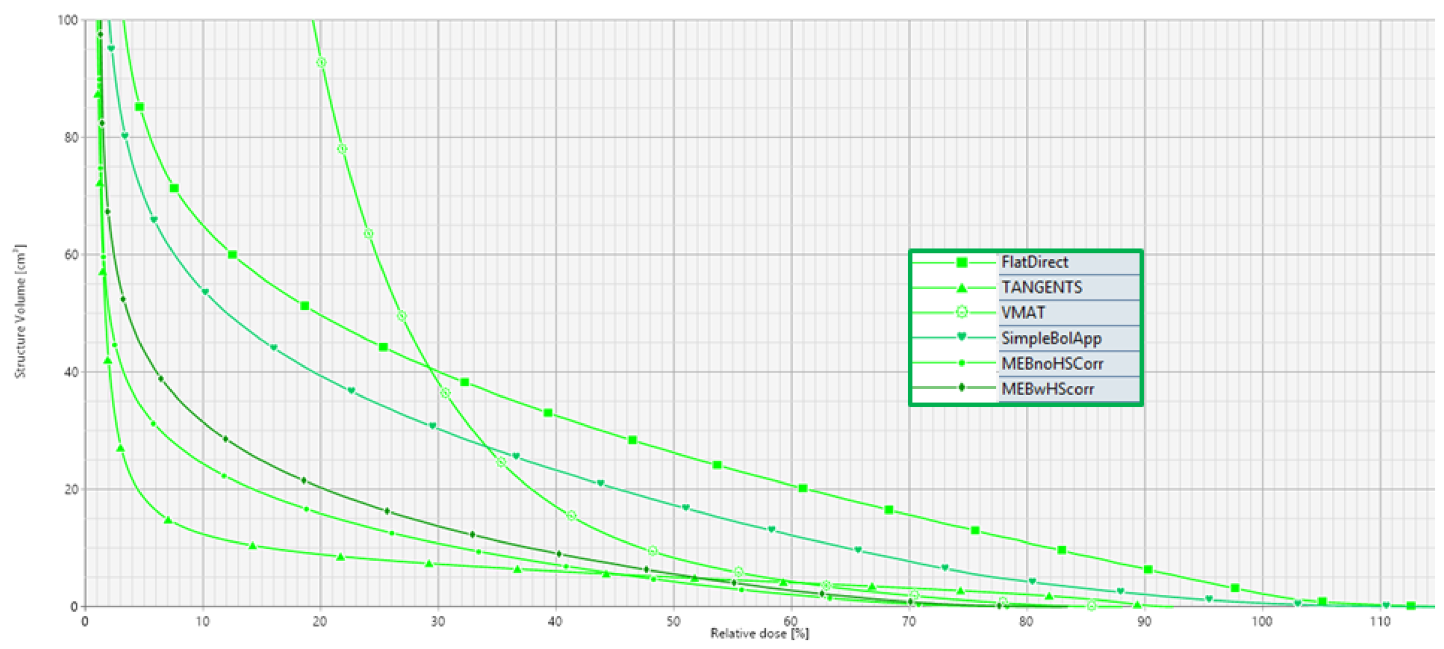

Fig. 3: Dose Volume Histograms (DVH) for brain

Homogeneity Index (HI)

- VMAT produced the most optimal HI (0.09), followed by tangents (0.14), with appositional electrons the least optimal (0.35)
- For the MEB plans, use of the hotspot correction improved the HI slightly (0.31 vs. 0.33)

Conclusion: The tangential plan was most optimal, due to low normal brain V80, V50 and V20, low HI, and acceptable ipsilateral lens dose. The VMAT plan provided the best dose homogeneity and ipsilateral lens sparing, at the expense of increased volume of brain receiving low and moderate doses. The MEB plans provided an improvement in the normal brain DVH distal to the PTV and were associated with acceptable ipsilateral lens dose and homogeneity. Hotspot correction allowed for an improvement in the dose homogeneity for the MEB electron plans.

In summary, MEB can provide benefits to complicated skin cancer cases and should be considered against other standard options.

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Reference:
Basaric, B., Majcher, C., Orbovic, R., Dennis, A., Robar, J.L. (2019, April) *A novel hotspot correction algorithm in Modulated Electron Radiation Therapy (MERT) utilizing 3D printed boli.* ESTRO38, Milan, Italy.