

Toward Online Adaptive Radiotherapy in Pediatric Neuroblastoma: A Dosimetric Comparison of IGRT and Ethos Emulator–Based Planning

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PURPOSE / OBJECTIVES

To evaluate the feasibility of online adaptive radiotherapy using Ethos Emulator 2.0 for pediatric abdominal neuroblastoma, aiming to maintain target coverage while reducing dose to organs at risk (OARs) and potentially enabling smaller treatment margins.

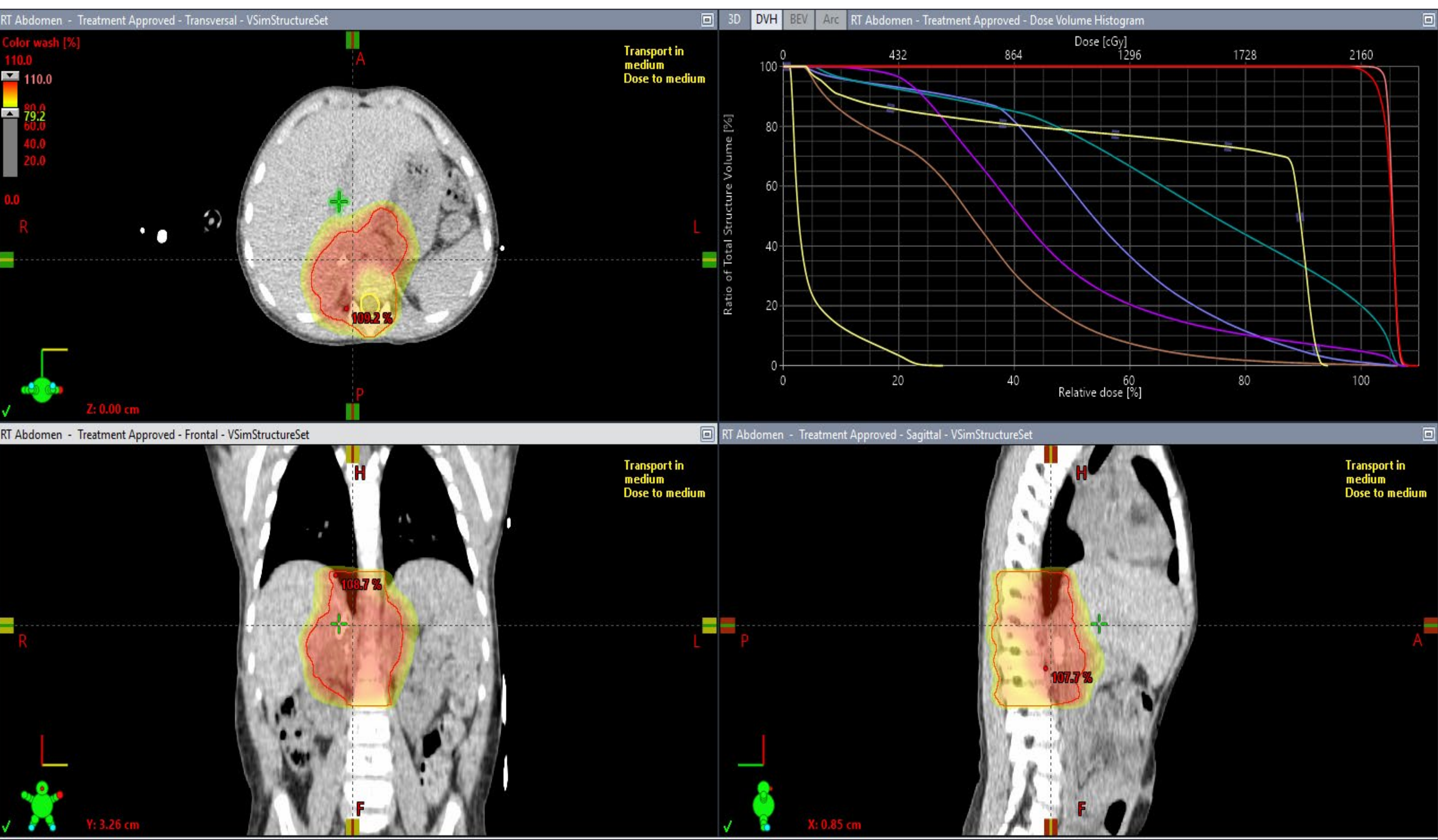
MATERIAL & METHODS

Five pediatric patients with abdominal neuroblastoma previously treated with VMAT and daily kV cone-beam CT (CBCT)–guided IGRT were retrospectively replanned using Ethos Emulator 2.0 with a 9-field IMRT technique. Prescription doses were 21.6 Gy in 12 fractions to the primary target and 18 Gy to involved vertebral bodies. Planning CTs, structure sets, and twelve CBCTs per patient were imported into the emulator. As an initial step, CT-based Ethos plans were compared dosimetrically with the original IGRT plans. The Ethos online adaptive workflow was then tested on daily CBCTs to evaluate automated contour generation, plan optimization, and dose recalculation.

MATERIAL & METHODS

Third-party software (Velocity) was used to perform deformable dose accumulation from daily CBCTs to the planning CT for scheduled and adaptive plans. Due to time constraints, the full CBCT-based adaptive workflow was completed for one patient to demonstrate feasibility; accumulated CBCT dose results are not reported here.

RESULTS



Example of isodose line distribution for pediatric abdominal neuroblastoma.

RESULTS

For CT-based planning, target coverage and OAR sparing were comparable between IGRT and Ethos plans. For PTV_2160, V95% was 98.93% $\pm$ 2.36% for IGRT versus 99.38% $\pm$ 1.33% for Ethos ($p = 0.72$), and Dmax was 109.1% $\pm$ 0.93% versus 110.46% $\pm$ 3.64% ($p = 0.46$). For PTV_1800, V95% was 98.68% $\pm$ 0.65% versus 99.55% $\pm$ 0.90% ($p = 0.83$). No statistically significant differences were observed for kidneys, liver, lungs, or spinal cord dose metrics (all $p > 0.4$).

SUMMARY / CONCLUSION

Ethos Emulator 2.0 produced online-adaptive–capable plans with target coverage and OAR doses comparable to clinical IGRT plans for pediatric abdominal neuroblastoma. Demonstration of a CBCT-based adaptive workflow supports future studies to quantify dosimetric benefits and evaluate the potential for margin reduction.