PTCOG-AO 2025
HONG KONG
NOV 7-9
PTCOG-AO

Theme: Clinical **Abstract No:. PTCOG-AO2025-ABS-0104**

Auto-Segmentation of Craniospinal OARs Using Integrated Anatomical Site-Specific Deep Learning Models: Evaluation of Accuracy and Clinical Efficiency

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Background / Aims:

No unified deep learning model exists for auto-segmentation of all craniospinal organs at risk (OARs). This study assesses the feasibility of combining multiple region-specific deep learning segmentation (DLS) models in pediatric and adult craniospinal irradiation (CSI) with intensity-modulated proton therapy (IMPT). Geometric accuracy, dosimetric performance, and workflow efficiency are evaluated.

Subjects and Methods:

- Retrospective analysis of **20 IMPT CSI plans** (patients aged 10–28).
- Median CSI prescription: 30.33 GyRBE in 17.5 fractions (23.4/13 – 35.07/21 GyRBE/fractions).
- Sequential application of head-neck, thorax-abdomen, and pelvis DLS models within RayStation v12.
- Segmentation time recorded for 50 OARs per patient.
- Manual contours (**30 OARs**) established ground truth; segmentation accuracy evaluated using Dice Similarity Coefficient (**DSC**) and Hausdorff Distance (**HD**).
- Dosimetric accuracy assessed via **mean and maximum absolute dose differences** (ΔDmean, ΔDmax) between DLS and ground truth contours.

Result:

Patient characteristics: (Median Values)

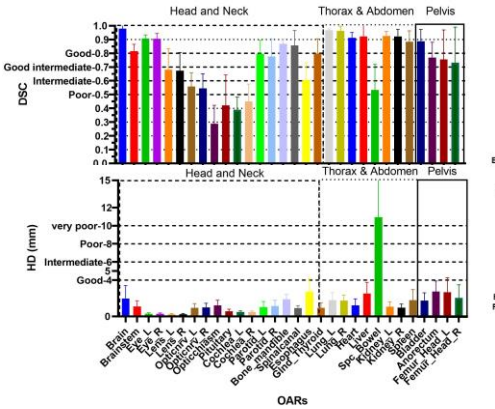
- Age: 14.5 years; height: 1.63 m; BMI: 20.86 kg/m²; CSI length: 0.69 m.

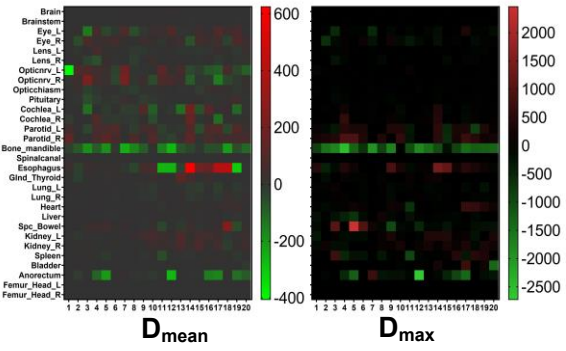
DSC: No. of OARs Good (>0.8): 16; Intermediate (0.6–0.8):7; intermediate-poor (0.5–0.6): 3; poor (<0.5):4 OARs

HD: Good (<4 mm) except bowel (mean 10.94 ± 4.90 mm).

Dosimetric differences per OAR (average): ΔDmean: ±150 cGyRBE; ΔDmax: ±1300 cGyRBE.

Average auto-segmentation time: 5.46 ± 1.06 minutes for 50 OARs.





Conclusion:

Efficient, multi-site DLS models enable rapid craniospinal OAR auto-segmentation in less than 6 minutes, supporting accurate results for most organs. This workflow saves substantial time, with few OARs needing further refinement for optimal performance.