PTCOG-AO 2025
HONG KONG
NOV 7-9

PTCOG-AO

Theme: Physics Abstract No. PTCOG-AO2025-ABS-0112

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An Automated Framework to Track Vertebrae Growth in Paediatric CSI Patients: correlating CT and MRI measurements for long-term late effects assessment

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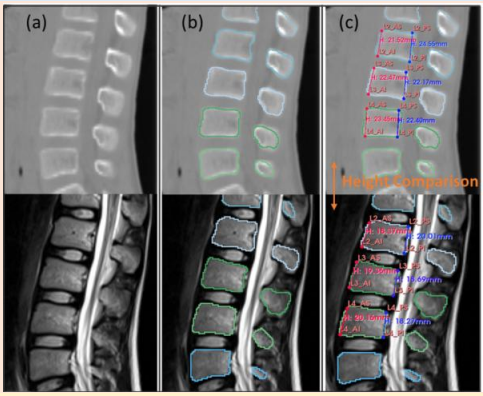
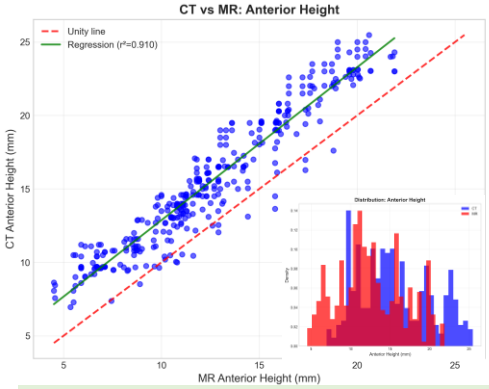
Background / Aims: In paediatric radiation therapy, cranio-spinal irradiation (CSI) either via photon- or proton-beams is associated with late adverse effects (LAEs) such as growth retardation, scoliosis, and kyphosis. In this study, an AI-model based automated framework is developed to assess the growth-rates of vertebral heights by quantifying the 3D-volumetric effects on individual vertebral bodies on both CT-MR pair datasets.

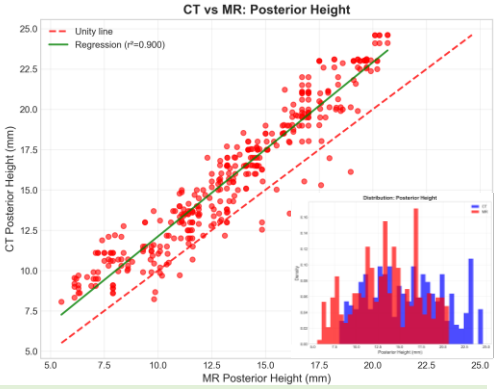


Subjects and Methods: The models extract anterior and posterior vertebral heights using two nnU-Net-based segmentation networks for CT and T2-weighted-MR, which were trained on 250 CT (170 Adult, 70 Paediatric) and 240 T2w-MR (210 Adult, 30 Paediatric) training pairs. The study analysed 21 paired CT and T2w-MR scans from the same paediatric patients (aged 5–12 years) by measuring a total of 540 vertebral bodies (C4–L5 level).

Result:

- Inclusion of paediatric data during training improved the model performance, with the relationship between age and vertebral height best described using linear regression models (R2>0.75).
- The highest growth-rates on L-spine (1.08-1.16 mm/y), followed by T-spine (0.67-1.03 mm/y), and C-spine (0.48-0.66 mm/y).
- Both CT-MR networks achieved DSC above 0.8 and mean surface distance (MSD) below 3.5±0.8 mm for test cases.
- Statistically significant differences on the Wilcoxon test between CT-MR pair, attributed to the inverted hypointense intensity of cortical bone thickness on Spine-Echo T2w-MR images due to low proton density and rapid signal decay.





Conclusion: We have developed dual imaging modality-based AI models to automatically extract growth-rates from vertebral height measurements and directly correlate its CT-MRI paired measurements for paediatric patients. This automated framework has great potential to bridge the gap between CT-MR based LAEs measurements to improve growth monitoring in CSI paediatric cohorts.