ESTRO

Abstract

Title

AI-based OAR annotation for pediatric brain radiotherapy planning

Authors

Thais Roque[1], Pierre-Yves Bondiau[2], Stephanie Bolle[3], Alexandre Escande[4,5,6], Loig Duverge[7], Charlotte Demoor[8,9], Angela Rouyar-Nicolas[3], Basile Bertrand[10], Arthus Cannard[10], Leo Hardy[10], Catherine Martineau-Huynh[1], Nikos Paragios[10,11], Eric Deutsch[3], Charlotte Robert[3]

Authors Affiliations

[1]TheraPanacea, Clinical and Partnerships Affairs, Paris, France; [2]IMPT, Centre Antoine Lacassagne, Radiation Oncology , Nice, France; [3]Gustave Roussy Cancer Campus, Department of Radiation Oncology, Villejuif, France; [4]Oscar Lambret Comprehensive Cancer Center, Department of Radiation Oncology, Lille, France; [5]H.Warembourg School of medicine, University of Lille, School of Medicine, Lille, France; [6]University of Lille, CRIStAL Laboratory, UMR 9189,, Lille, France; [7]Eugène Marquis Comprehensive Cancer Center, Department of Radiation Oncology, Rennes, France; [8]Centre François Baclesse, Radiotherapy department, Caen, France; [9]CHU Angers, Pediatric Oncology, Angers, France; [10]TheraPanacea, Research and Development, Paris, France; [11]CentraleSupelec, University of Paris-Saclay, Computer Science and Applied Mathematics, Gif-sur-Yvette, France

Purpose or Objective

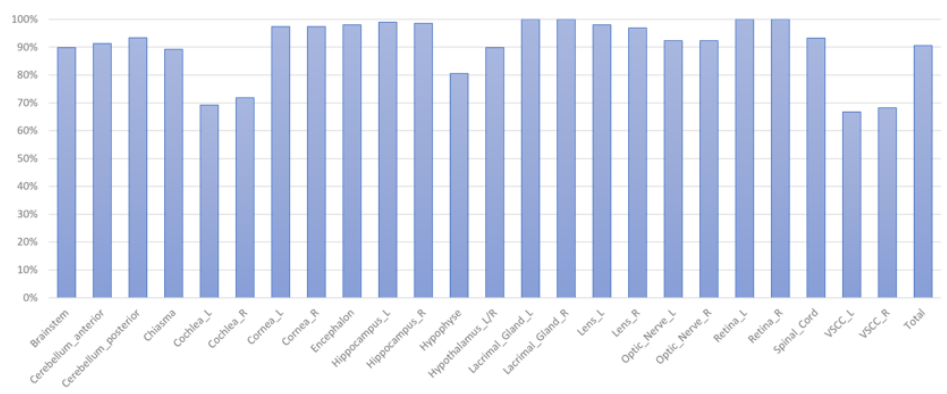
Pediatric central nervous system (CNS) tumors, the second most common childhood malignancy and the most common solid tumor in children, comprise tumors of the brain, the spinal cord, and the meninges. The management of brain tumors depends on patient age, histology, tumor location and extent but typically involves a radiation therapy (RT) planning based on computed tomography (CT) and magnetic resonance imaging (MRI). MRI is acquired for detailed tumor localization and delineations of the target and OARs thanks to its excellent soft-tissue contrast. Contouring, especially for pediatric cases, suffers from inter/intra expert variability while being time consuming. In this study, a commercial solution for automatic OAR delineation, previously trained and validated on adult patients, was tested on an unseen cohort of pediatric patients to evaluate its clinical acceptability.

Materials and Methods

ART-Net, a CE-marked, FDA-cleared anatomically preserving deep-learning ensemble architecture for automatic annotation of OAR was evaluated using pediatric patients from 2 centers selected across 4 different age groups 0-2y (9), 2-5y (10), 5-10y (10) and 10-15y (10). For each patient, automatic *contours (AC)* of 24 OARs *were* performed and submitted to 5 experts across 4 centers for evaluation. Contours were scored as A/acceptable, B/ acceptable after minor corrections, and C/ not acceptable for clinical use. To avoid any bias, experts were blind to the fact that all contours were generated automatically.

Results

AC were generated in a mean time of 0.5s per scan slice. 90.54% of structures were considered clinically acceptable (scored as A or B) across all ages. In 3% of the cases, the algorithm failed to recognize structures such as vestibular and semicircular canals (VSCC) and cochlea, for which T1w is not the reference sequence. Across all ages and organs, the 5 experts agreed on 44% of all contours, hinting on the intervariability of the contouring practice. Table 1 shows how the performance of the software increases with age group: age groups of 5-10y and 10-15y show higher clinical acceptability (93.17% and 91.25%) than groups 0-2y and 2-5y (88.72% and 88.83%). Only 2.76% of the structures were scored as a C, with the least performing organs being brainstem and anterior cerebellum, especially for the youngest age groups of 0-2y and 2-5y (17.89% and 22.00%), especially due to the presence of tumors in the posterior fossa which deformed these OARs and led to impossibility of distinguishing between tumor and healthy tissue.



Scoring/ Age group	A	B	C	N/A	N/M	A/B
All ages	77.58%	12.96%	2.76%	3.23%	3.48%	90.54%
0-2y	73.71%	15.00%	3.98%	3.70%	3.61%	88.70%
2-5y	74.25%	14.58%	3.75%	4.67%	2.75%	88.83%
5-10y	79.25%	12.00%	2.33%	2.92%	3.50%	91.25%
10-15y	82.75%	10.42%	1.08%	1.67%	4.08%	93.17%

Figure 1 Top: Percentage of structures evaluated as A or B (i.e. considered clinically acceptable) per organ across all age groups.Bottom: Table 1 Expert-based scoring of AI-contours as an average over all structures (n=24), patients (n=39) and experts (n=5). With N/A and N/M meaning contours not delineated by the algorithm or not graded by the experts, e.g due to the presence of tumors that led to impossibility of contouring.

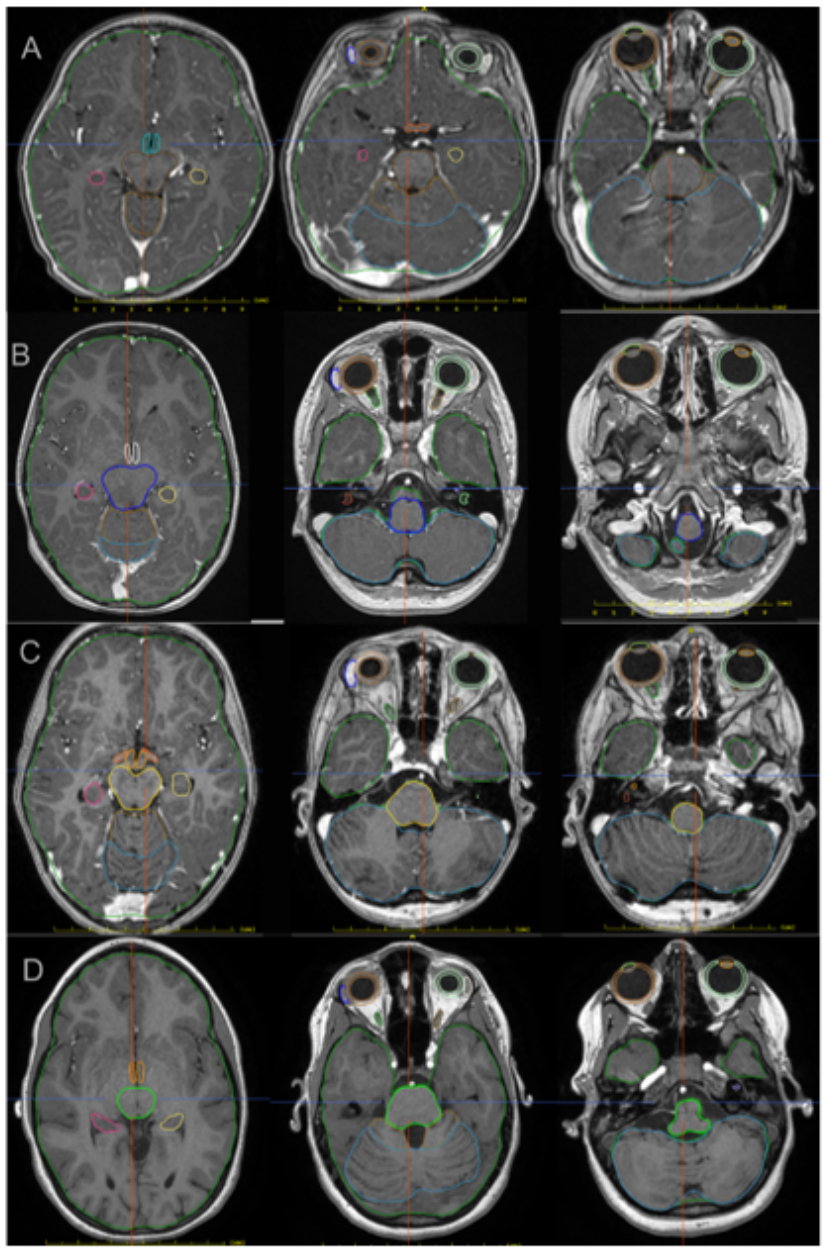


Figure 2 Examples of non-edited automatic delineations for pediatric MR scans for a patient aged between 0-2y (A), 2-5y (B), 55-10y (C) and 10-15y (D) using a commercially available adult-based model for OAR delineation.

Conclusion

We show first results for the evaluation of MR-brain AI-based auto-contouring for pediatric cases. The results show very good acceptance, highlighting the high usability of the commercial tool for MR annotation for pediatric brain cases and its clinical implementation feasibility. In the future, a comparison between AI and human expert and a dosimetric evaluation will be performed.