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GTV Autosegmentation for Palliative Head and Neck Radiotherapy

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INTRODUCTION

- Palliative head and neck treatments are an important aspect of radiotherapy
- Understudied for automatic segmentation
- Contouring head and neck gross tumor volumes (GTVs) is particularly difficult due to low contrast and anatomical ambiguities including surgery or extensive disease

AIMS

- To develop a 3D deep-learning model for the automatic segmentation of gross tumor volumes (GTVs) for palliative head and neck radiotherapy planning

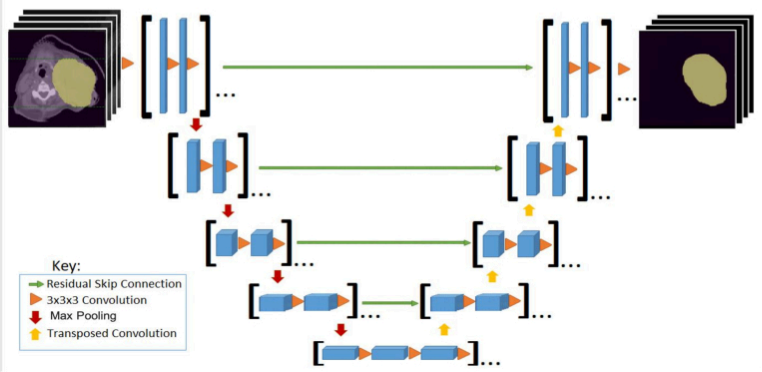
METHODS

Data Curation

- 104 palliative treatment plans
  - Non-contrast CTs
  - Physician-approved GTV contours
- All plans used opposed lateral beams for treatment
- 68 training and 18 validation cases
- 18 cases reserved for final evaluation and never seen by model during training

METHODS (continued)

Model



(Image modified from Çiçek, Ö et al. 2016)

- Modified 3D U-Net trained to automatically segment GTVs[1]
- Adam optimizer
- Composite Dice similarity coefficient (DSC) and false-negative DSC loss

Evaluation

- Dice similarity coefficient (DSC) and mean surface distance (MSD) for 3D predicted GTV
- Lateral agreement scored with 2D DSC
- Predictions imported into treatment planning system with 1.5-cm margin expansion and compared with physician-approved treatment plans

RESULTS

- 10% (*n*=2) of 18 test predictions exhibited poor DSC scores when comparing predicted and physician-approved GTVs (3D DSC > 0.2) and were excluded from further evaluation
- Lateral predicted boundaries were most consistent with ground truth values, with mean and maximum DSC 0.77 and 0.93, respectively
- Over the entire GTV, mean DSC was 0.66 (max 0.87) and mean MSD was 4.6 mm (min 1.9).
- A majority (88%, n=14) of treatment plans prepared with 1.5-cm margin expansion received a minimum of 95% prescription dose

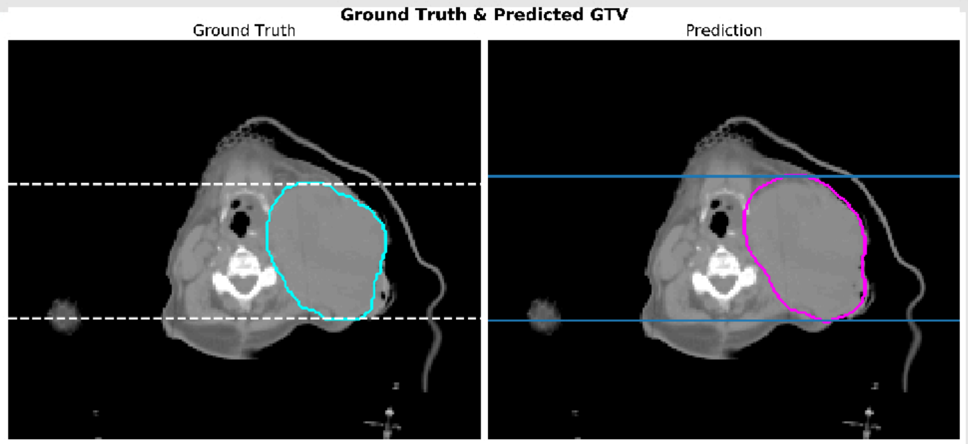


Figure 1: Single slice of the clinical and predicted GTV. For this example, the anterior and posterior boundaries of the predicted mask can be seen to be in close proximity to the clinical boundaries.

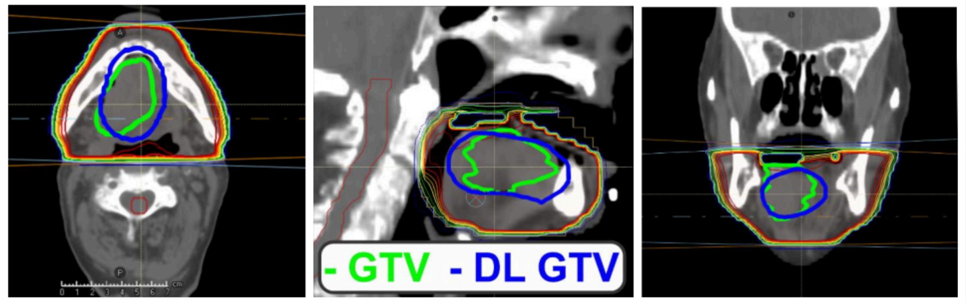


Figure 2: Comparison of clinical GTV (green) and predicted GTV (blue) in a treatment planning system. Field apertures are conforming to predicted GTV plus a uniform 1.5 cm expansion.

Table 1: GTV predictions agreement with ground truths for the 16 evaluated predictions. The first two columns are over the entire 3D GTV. Lateral DSC is only over the area enclosed by the lateral boundaries of the GTV.

3D DSC (range)	3D MSD (range)	Lateral DSC (range)	≥ 95% Prescription Dose
0.66 (0.44-0.87)	4.6-mm (1.9-8.8)	0.77 (0.56-0.93)	88%

CONCLUSIONS

- Convolutional neural networks may be useful for rapidly autosegmentation of GTVs for palliative head and neck radiotherapy
- Lateral DSC values and agreement with prescription dose indicate our approach is feasible

REFERENCES

1. Çiçek, Ö., Abdulkadir, A., Lienkamp, S. S., Brox, T., & Ronneberger, O. (2016). 3D U-net: Learning dense volumetric segmentation from sparse annotation. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 9901 LNCS, 424–432. https://doi.org/10.1007/978-3-319-46723-8_49

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