

Quantitative and qualitative evaluation of an automatic GTV contouring tool in pre-radiotherapy MRI in glioblastoma treatment

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Purpose/Objective:

Glioblastoma (GB) is the most common and malignant primary tumor of the central nervous system. Disease recurrence occurs shortly after initial treatment, potentially overlapping with the period between surgery and radiotherapy initiation. This complicates tumor target identification, leading to tedious and variable contouring of the Gross Tumor Volume (GTV) for radiotherapy planning. Hence, the development of efficient automatic segmentation of GBM to improve reproducibility and gain time is an important challenge in the field. In this study, we present an auto-segmentation model GTV in GB undergoing biopsy, evaluating its ability to generate clinically valid contours to address these challenges.

Material/Methods:

We employed the UNet architecture to develop a tumor segmentation model, trained and tested on T1 contrast-enhanced MRI images from a multicentric dataset comprising N=1100 patients for training and N=275 for testing on biopsy patients. Trained radiation oncologists validated enhancing tumor and necrotic regions within the dataset, combined to form a clinical pre-radiotherapy GTV. Evaluation of automatic versus manual contours' similarities on the test dataset using Dice similarity coefficient (DSC) and Hausdorff distance (HD95) guided the selection of a qualitative evaluation subset of 24 cases. This subset testing dataset comprised 12 automatic contours and 12 manual contours that were presented for a blinded review to three radiation oncologists. Contours were rated on an A-B-C grid, with A for satisfactory, B for minor changes, and C for major changes. A and B ratings were considered acceptable, defining the acceptance rate for each organ

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Results:

Automatic contours achieved an average DSC of 0.90, and an average HD95 of 7.3mm compared to manual contours across all test datasets. Qualitative evaluation on subset test dataset results is summarized in table 1. Average ratings across all experts show no difference in A+B ratings between automatic and manual contours. Similarly, inter-expert agreements were comparable between automatic and manual contours; for automatic contours, experts agreed on the rating attributed to 33% of contours (4/12 cases) whilst they agreed on 42% of manual contours (5/12) cases.

	Automatic contours				Manual contours			
	A	B	A + B	C	A	B	A + B	C
Expert 1	31%	38%	69%	31%	25%	58%	83%	17%
Expert 2	62%	23%	85%	15%	75%	8%	83%	17%
Expert 3	58%	25%	83%	17%	67%	17%	83%	17%
Expert average	50%	29%	79%	21%	56%	28%	83%	17%

Table 1. Qualitative evaluation of N=12 automatic contours and N=12 manual contours on pre-operative GBM cases.

Conclusion:

In conclusion, our results indicate that the automatic contouring approach demonstrates comparable qualitative performance to manual delineation, as evidenced by the agreement in A+B ratings among experts and the similar levels of inter-expert consensus between automatic and manual contours.