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Comparative Efficiency of Atlas-Based OAR Contouring versus Manual Contouring: Volume and Dosimetric Impact in Stereotactic Radiotherapy for Multiple Metastases

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Navitha S [1], Sonal Chauhan [2], Piyush Kumar [3]

1. Assistant Professor cum Medical Physicist Department of Radiation Oncology, Shri Ram Murti Smarak Institute Of Medical Sciences, Bareilly, IND 2. Radiation Oncology, Amity university, Noida, IND 3. Radiation Oncology, SRMS INSTITUTE OF MEDICAL SCIENCES, BAREILLY, IND

Corresponding author: Navitha S, navitha.selvi@gmail.com

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Abstract

Objectives:

Stereotactic radiotherapy (SRT) is a highly precise form of radiation treatment commonly employed to target multiple metastases while minimizing damage to surrounding healthy tissue. The accuracy of SRT largely depends on the delineation of organs at risk (OAR), which can significantly affect treatment outcomes. Traditional manual contouring methods, while widely used, can be time-consuming and subject to inter-observer variability. Recent advancements in atlas-based contouring techniques promise to enhance the efficiency and accuracy of OAR delineation. However, the clinical benefits of these methods in terms of volume consistency and dosimetric impact remain underexplored. The primary objectives of this study are to evaluate the time efficiency of atlas-based OAR contouring compared to manual methods during the treatment planning process for patients with multiple metastases. We will analyze the differences in OAR volumes contoured using both techniques and assess the dosimetric outcomes, focusing on critical metrics such as dose volume histograms (DVHs) to determine the impact on target coverage and OAR sparing. Additionally, the study will investigate the consistency and reproducibility of atlas-based contouring across various cases of metastatic disease.

Methods:

This study utilized a comparative approach to evaluate the efficiency and dosimetric impact of atlas-based OAR contouring versus manual contouring in stereotactic radiotherapy for patients with multiple metastases. The Velocity Auto-Contouring Workstation was employed for atlas-based OAR delineation, utilizing established anatomical models for automated segmentation. In contrast, manual contouring was performed in the Eclipse Treatment Planning System by experienced radiation oncologists. A cohort of patients diagnosed with multiple metastases, scheduled for stereotactic radiotherapy, was included after obtaining ethical approval and informed consent. For contour creation, OARs were automatically contoured in Velocity and then reviewed and adjusted by a radiation oncologist. Manual contours were created in Eclipse for the same patient datasets. All treatment plans were developed in Eclipse, incorporating parameters such as target dose and treatment techniques. Dosimetric evaluations were performed using dose volume histograms (DVHs), where key metrics such as mean dose, maximum dose, and volumes receiving 85% , 95% and 120% dose levels were recorded for target volumes and OAR doses were also recorded. The time taken for contouring and planning was also recorded to assess time efficiency, including the time for initial contouring, adjustments, and final treatment plan approval. Statistical analyses were conducted using paired t-tests to compare dosimetric outcomes and time efficiency between the two contouring methods, with a significance level set at $p < 0.05$.

Results:

There was a significant difference in time efficiency between auto contouring and manual contouring; however, the total time also included verification and acceptance by the oncologist.

Conclusion(s):

In summary, our study demonstrates that atlas-based auto contouring is an effective and time-efficient alternative to manual contouring for organs at risk in stereotactic radiotherapy for multiple metastases. The automated approach significantly reduces contouring time while providing detailed and consistent

contouring structures. However, despite its advantages, thorough verification by experienced clinicians remains essential to ensure the accuracy and appropriateness of the contours generated. This combination of efficiency and expert oversight can enhance treatment planning and improve patient outcomes in clinical practice. Future studies should continue to explore the integration of auto contouring technologies with established verification protocols to further optimize the radiotherapy workflow.