

Evaluation of an Artificial Intelligence-Based Software for Adaptive Radiotherapy in Head and Neck Cancer Treatments

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Abstract Text:

Purpose/Objective(s): During radiotherapy for head and neck cancer, anatomical changes can impact dose distribution, highlighting the need for adaptive radiotherapy (ART). However, the lack of automated tools and challenges in patient selection hinder ART's clinical adoption. This study introduces an AI-driven solution for assessing the need for replanning and implementing patient-specific workflows. After evaluating dose calculation reliability on synthetic-CT (sCT), dosimetric comparisons quantify deviations from the initial plan and determine the benefits of replanning due to anatomical variations

Materials/Methods: TheraPanacea's AdaptBox module utilizes AI-generated synthetic-CTs from daily CBCTs to calculate treatment plans. The neural network (GAN) is trained on planning CTs and CBCTs, enabling generation of high-quality sCTs with an expanded field of view. Automatic contouring of organs at risk and propagation of target contours are performed, followed by dose calculation on the sCT. To assess the quality of the sCTs generated, the calculation was compared for 10 patients with that on the replanning CT. Differences in CTV D50% and D95% were revealed. Dosimetric impact assessment on 7 patients included target volume coverage, conformity, and homogeneity indexes, as well as analysis of organs at risk doses (e.g., Dmean for parotids, D1% for spinal cord and brain stem). Reduction in xerostomia risk associated with replanning was calculated using a Poissonian linear NTCP model for each patient

Results: Replanning CT and sCT dose calculation discrepancies are minimal, averaging a 0.3% difference. Target volume coverage remains robust, meeting ICRU criteria with no significant difference at the time of the replanning decision between planning CT and sCT coverage. Conformity index stability is noted, though a slight decrease in homogeneity index is observed. Consistent with literature findings, sCT shows increased dose to OARs, approximately 3-4 Gy for parotids and 3 Gy for spinal cord and brainstem. Replanning marginally improves coverage but significantly reduces dose to OARs: 3.5-4.6 Gy for parotids, 2.9 Gy for spinal cord, and 3.4 Gy for brainstem. Replanning consistently reduces xerostomia risk (2-24%), particularly beneficial for patients with intermediate parotid doses (23-32 Gy), where residual risk drops below 20%

Conclusion: AI-based solutions, including sCT generation from daily CBCT and full-scale dose calculation, offer promising avenues for ART. They facilitate easier implementation of prospective studies, reducing bias and enabling more relevant comparisons. This approach allows for targeted conclusions about specific patient groups, such as those with similar mean doses to the parotids, to assess the benefits of replanning. Addressing the limitations of recent studies like ARTIX, which failed to show clear benefits of replanning on xerostomia, requires a case-by-case analysis rather than considering the patient cohort as a whole.

Track:

Special Session

Subcategory:

Adaptive and Automated Processes: Offline and Online

Secondary Track:

Radiation and Cancer Physics

Secondary Subcategory:

Adaptive and Automated Processes: Offline and Online

Final Paper##:

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