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abstract

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Comparative Evaluation of DIR-Based Auto-Adaptive, Manual, and Semi-Automated Contouring for Pelvic OARs in Cervical Cancer Adaptive Radiotherapy

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Introduction: This study evaluates the geometric accuracy and workflow efficiency of the Monaco Treatment Planning System auto-adaptive contouring algorithm, which uses deformable image registration (DIR), compared with expert manual delineation and a modelled semi-automated method. The analysis focuses on bladder, rectum, and bowel contours in cervical cancer patients requiring adaptive replanning. The aim is to determine whether DIR-based automated methods can maintain reliable geometric fidelity while improving contouring throughput during time-sensitive adaptive radiotherapy.

Methodology: Six retrospective cervical cancer cases treated with adaptive radiotherapy at BMC were analysed. Each patient underwent a planning CT and a re-simulation CT triggered by anatomical deviations seen on cone-beam CT. Organs-at-risk were contoured manually using Monaco's auto-adaptive DIR algorithm. Contouring times were recorded, and semi-automated contouring time was estimated using a weighted editing-effort model derived from TG-132 and published refinement behaviour. Quantitative evaluation included absolute and percentage volume differences, Pearson correlation, theoretical Dice Similarity Coefficient (DSC) maxima from paired volumes, and interpretation of geometric performance ranges based on pelvic DIR accuracy benchmarks. Extra attention was given to DIR performance in regions with variable deformation, particularly the rectum and bowel.

Results: DIR-driven auto-adaptive segmentation significantly improved workflow, reducing mean contouring time to 0.81 minutes compared with 31.8 minutes for manual delineation. Estimated semi-automated contouring required 14.3 minutes, providing a 55.2% reduction relative to manual.Strong volumetric agreement was observed across organs, with Pearson correlation coefficients of 0.99 for bladder,0.95 for rectum, and 0.99 for bowel. Theoretical DSC maxima were 0.96, 0.93, and

0.97 for bladder, rectum, and bowel. Interpreted against DIR accuracy benchmarks, these values indicate high geometric agreement for bladder and bowel and moderate agreement for rectum, reflecting expected deformation variability.

Conclusion: Monaco's DIR-based auto-adaptive contouring provides workflow optimisation and strong geometric consistency with manual delineation for most pelvic organs. The semi-automated method offers an efficient intermediate option when targeted refinement is required, supporting safe, rapid, and streamlined implementation of adaptive treatment planning.

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