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JOINT AAPM | COMP MEETING

Automated Assessment of Target and OAR Volume Changes to Determine the Optimal Re-Planning Point for Head-and-Neck Patients

I. Dragojević Ph.D.[1], R. Hachadorian Ph.D.[1], R. Manger, PhD[1]
Dept. of Radiation Medicine and Applied Sciences
University of California San Diego

ABSTRACT

Purpose: To evaluate the impact and viability of implementing an automated weekly check tool that tracks daily volume changes of target volumes and organs at risk (OARs) for head and neck treatments, optimizing when to re-scan and re-plan the patient.

Methods: Our clinic implemented the ChartCheck Adaptive (CCA) (Radformation Inc., New York) software to assess day-to-day dose changes for targets and OARs by analyzing volumetric changes to AI-generated contours on daily CBCT scans for head and neck patients. We configured the system to automatically flag cases in which tumor or organ-at-risk volumes exceed predefined change thresholds, enabling physicists to predict when rescans and re-planning are necessary.

Results: Volume changes were assessed for intermediate-risk and low-risk clinical target volumes (CTVs), as well as for right and left parotid OARs. We randomly selected 16 patients (8 with re-sim and 8 without re-sim) to evaluate. On average, the patients that received a re-sim were re-planned at fraction 19 based on physician daily imaging review. The volume changes that were assessed in CCA indicated that significant changes (>10%) in CTVs and parotid volumes are observable between fractions 16 and 21. The target and OAR volume changes after the re-sim were significant enough that when compared to first fraction, the volume changes would exceed the 10% threshold, which is a metric easily trackable by CCA.

Conclusion: This data-driven approach can replace the labor-intensive manual review traditionally performed by physicians, which relies on visual assessment of daily images rather than quantitative volumetric and/or dose metrics. This approach allows for replanning resources to be strategically allocated rather than conducting subjective, clinician-determined reviews, thereby improving clinical efficiency. In the future, we aim to analyze dosimetric changes in addition to volume changes as indicators for replanning.

CONTACT

I. Dragojevićn PhD, DABR
Professor
UC San Diego Health, Radiation Medicine & Applied Sciences
Encinitas, CA 92024
idragojevic@health.ucsd.edu

INTRODUCTION

Anatomical changes throughout a course of Head and Neck (HN) compromises the balance achieved between tumor coverage and toxicity to critical structures, such as optics and parotids. An adaptive radiotherapy (ART) tool created by Radformation Inc. (New York, NY) addresses this by recalculating the treatment plan on a synthetic CT deformed to treatment day anatomy using cone beam CT (CBCT). We have utilized this clinical tool in an effort to identify the magnitude of volumetric or dosimetric changes in a given target or organ-at-risk (OAR) which characterizes the optimal replanning point, automatically. Ideally this would eliminate reliance on labor- and resource-intensive physician review of daily CBCT images, a process that is inherently subjective.

METHODS

A retrospective cohort of 16 H&N patients was carried through for analysis (*Figure 1*): 8 who received a re-simulation as part of their clinical care (*Fig 1b*), and 8 who did not (*Fig. 1a*). Volume change trends for intermediate (INT) and low (LOW) target volumes + left/right parotids were tracked across all fractions. For our re-sim cohort, volumetric changes were additionally computed relative to the re-simulation fraction to assess the impact of adaptive replanning (*Fig 1c*). One case study on dosimetric tracking was also assessed in *Figure 2.*

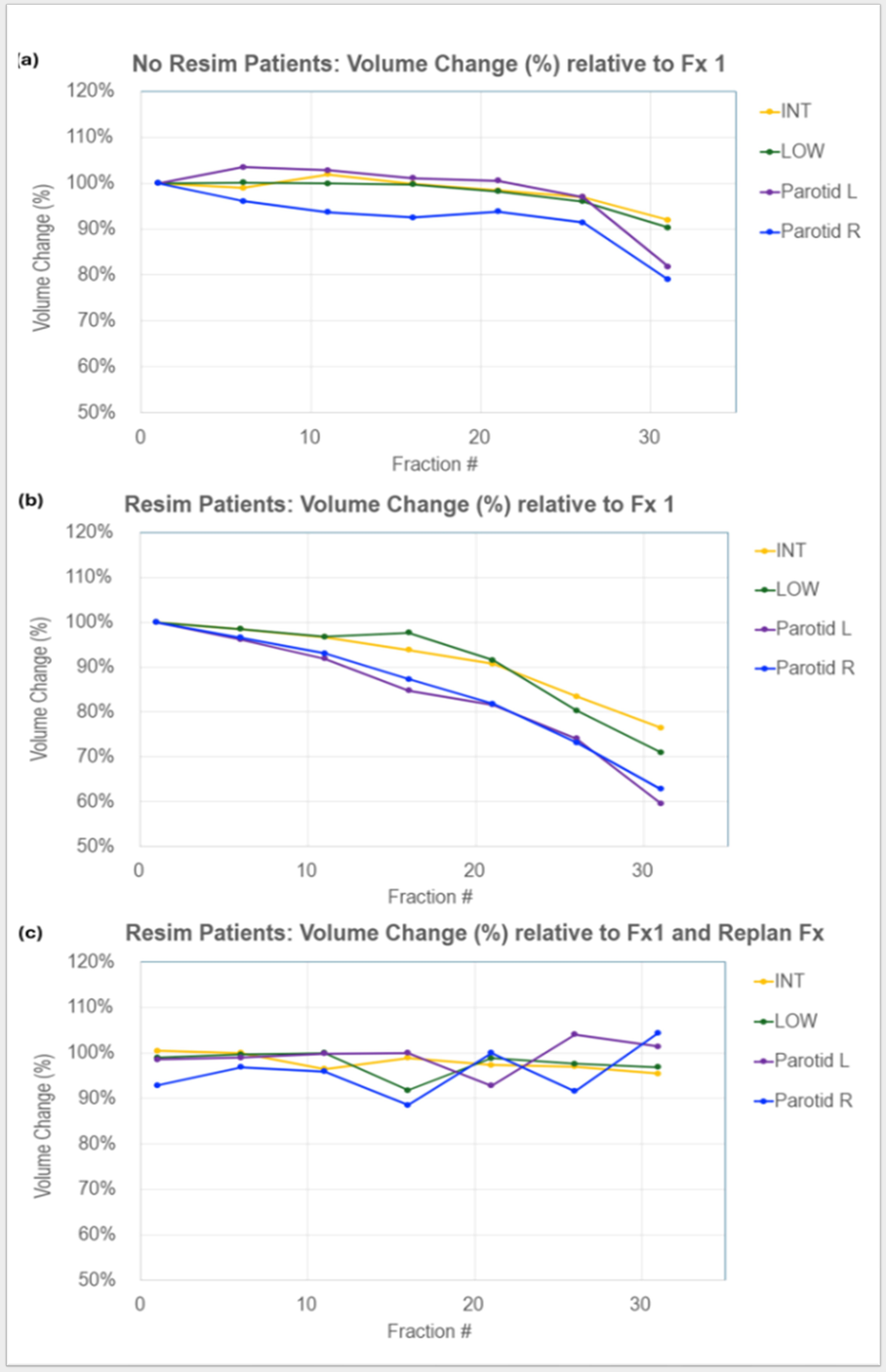

Figure 1: (a) the changes in low dose "LOW" and inter-mediate dose "INT" target volumes, as well as changes in left and right parotid OARs are shown for a cohort of patients (n=8) that received no re-sim. In (b), the same volume changes are mapped for patients that received a re-sim (n=8). These changes again are relative to only the first fraction. In (c), volume changes are computed for the same cohort of resim patients, only once the patient underwent a re-sim, the volumetric changes we computed relative to the re-sim fraction volume, in-stead of the first fraction only.

RESULTS

On average, **patients who received a re-sim were replanned at fraction 19.** CCA volumetric analysis revealed that significant changes (>10%) in CTVs and parotid volumes were consistently observable between fractions 16 and 21 in the re-sim cohort. In the no re-sim cohort, all volumetric changes remained within the 10% threshold throughout treatment, suggesting these patients were managed without replanning. For the re-sim cohort, when volume changes were recomputed relative to the re-simulation fraction (rather than the first fraction), trends became substantially flatter (Fig. 1c) —indicating improved target and OAR management following adaptive replanning.

A case study below in Figure 2 expands on our assessment of volumetric change thresholds to dosimetric thresholds. We use the constraints met pre-treatment to track meeting on optics constraints projected for the remaining fractions of treatment.

CONCLUSIONS

ChartCheck Adaptive (CCA) provides an automated framework for identifying patients who may benefit from adaptive replanning or generalized dose tracking. By flagging cases in which target or OAR volumes exceed a 10% change threshold, CCA enables physicists and physicians to make data-driven decisions about rescanning by replacing subjective visual review with objective volumetric metrics.

Delivered Dose

	Planned	Thu 5/28 4:39 PM 1	Fri 5/29 12:44 PM 2	Mon 6/1 6:19 PM 3	Tue 6/2 1:45 PM 4	Wed 6/3 12:41 PM 5	Thu 6/4 1:32 PM 6	Fri 6/5 1:20 PM 7
Constraint analysis using template UCSD Brain (Conventional) (CNS)								
Structure Constraint and Goal	**RadMonteCarlo planning result (Trigger threshold)**							
Retina_L D0.03cc ≤ 4500cGy	6034.11cGy (+5%)	✓ +0.03%	✓ +1.86%	✓ +1.21%	✓ +3.22%	✓ +1.77%	✓ +0.61%	✓ -0.35%
Retina_R D0.03cc ≤ 4500cGy	6031.11cGy (+5%)	✗ +7.33%	✓ +4.92%	✓ +2.64%	✓ +4.56%	✓ +1.96%	✓ +3.37%	✓ +1.82%
Cornea_L D0.03cc ≤ 4500cGy	6134.11cGy (+5%)	✓ -3.55%	✓ +0.57%	✓ -2.54%	✓ +2.62%	✓ -0.53%	✓ 0%	✓ -2.72%
Cornea_R D0.03cc ≤ 4500cGy	4808.11cGy (+5%)	✓ +2.83%	✗ +5.53%	✓ +2.87%	✓ +1.37%	✓ +3.79%	✓ -1.98%	✓ +1.52%
OpticChiasm D0.03cc ≤ 5400cGy	5345.11cGy (5400cGy)	✓ 5331.11cGy	✓ 5365.11cGy	✓ 5342.05cGy	✓ 5348.11cGy	✓ 5342.11cGy	✓ 5376.11cGy	✓ 5331.11cGy
OpticNerve_R D0.03cc ≤ 5400cGy	5228.11cGy (5400cGy)	✓ 5231.11cGy	✓ 5292.11cGy	✓ 5225.55cGy	✓ 5240.11cGy	✓ 5254.11cGy	✓ 5260.55cGy	✓ 5228.11cGy
OpticNerve_L D0.03cc ≤ 5400cGy	5325.11cGy (5400cGy)	✓ 5399.11cGy	✓ 5332.11cGy	✓ 5354.11cGy	✓ 5371.11cGy	✓ 5315.11cGy	✓ 5341.11cGy	✓ 5350.11cGy

Figure 2: A case study for a patient receiving treatment to the orbits of the eyes, where the physician specifically requested additional tracking on optic nerves, chiasm, corneas and retinas. Optic nerves and chiasm tracked max dose to 0.03cc (D0.03cc < 5400 cGy), the constraint originally set out in planning. We also tracked a 5% deviation from the dose achieved in planning to corneas and retinas. (Note that constraint (D0.03cc < 4500 cGy) was not originally met in planning due to overlap with target, thus we can not simply track the meeting of constraints.) CCA averages the calculated dose to the given structure over all delivered fractions, placing weight on the most recently delivered fraction as it scales to the total projected dose for the full course of radiotherapy. This projection is what appears for optic nerves and chiasm (green, passing results). For retinas and corneas, any time 5% from what was achieved in planning was exceeded, it appears red (values expressed as a percent deviation rather than projected dose). We see that on fraction seven, the patient is projected to meet constraints on optic nerves and chiasm.

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