2026 JOINT AAPM | COMP MEETING
JULY 19–22 | VANCOUVER, BC

Assessment of CBCT Post-Processing Algorithms for Head and Neck Adaptive Radiotherapy: A Cautionary Note on Dosimetric and Anatomical Accuracy

Rui Zhang, Alex Nicola Hanania, Amir Owrangi, Boran Zhou, Vincent Ugarte, Baozhou Sun
Department of Radiation Oncology, Baylor College of Medicine

Baylor College of Medicine

INTRODUCTION

Cone-beam CT (CBCT)–based adaptive radiotherapy (ART) has been successfully implemented for relatively stable anatomical sites such as breast, lung, and prostate. However, its application in head and neck (H&N) cancer, where anatomy changes rapidly remains insufficiently characterized.

AIM

To evaluate the dosimetric and anatomical accuracy of RayStation-generated corrected CBCT (cCBCT) and virtual CT (vCT) for ART in H&N cancer patients with significant anatomical change.

METHOD

For 10 H&N patients who underwent resimulation due to significant anatomical changes in our clinic, we analyzed cCBCT and vCT generated from the original planning CT in conjunction with the daily CBCT acquired closest in time to a repeat simulation (resim CT). The cCBCT, vCT, and the corresponding resim CT for each patient were compared. Evaluations included quantitative analysis of CT number Hounsfield unit (HU) accuracy and 3D dosimetric comparisons of the same resim treatment plan calculated on each dataset. Anatomical fidelity was also assessed visually.

RESULTS

In contrast to reports from other anatomical sites, both cCBCT and vCT exhibited substantial deviations in CT number distributions and corresponding dose calculations when compared with the reference resimulation CT.

RESULTS

Fig. 1 illustrates the pronounced anatomical discrepancies for a representative patient. Fig. 2 demonstrates the resulting dose distribution differences when the same treatment plan is recalculated on each image set. Quantitatively, the HU mean absolute error (MAE) was 200±44HU for cCBCT versus resim CT and 222±102HU for vCT versus resim CT. These HU inaccuracies propagated into clinically meaningful dosimetric errors, with gamma passing rates (2%/2 mm) of only 89.2±7.9% for cCBCT and 91.7±5.1% for vCT relative to the reference resim CT. (Fig.s 3 and 4).

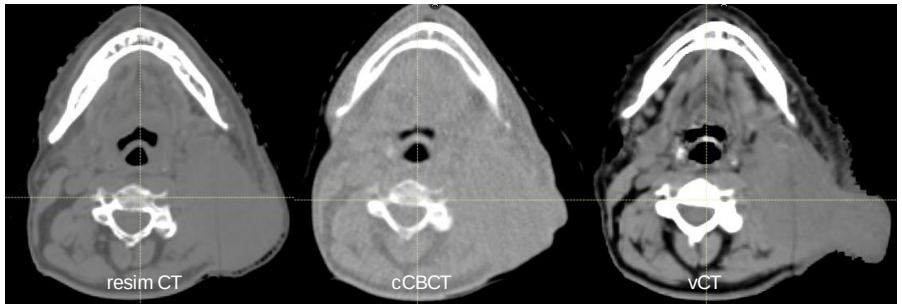

Fig 1. Axial CT images of the same slice for a typical H&N patient.

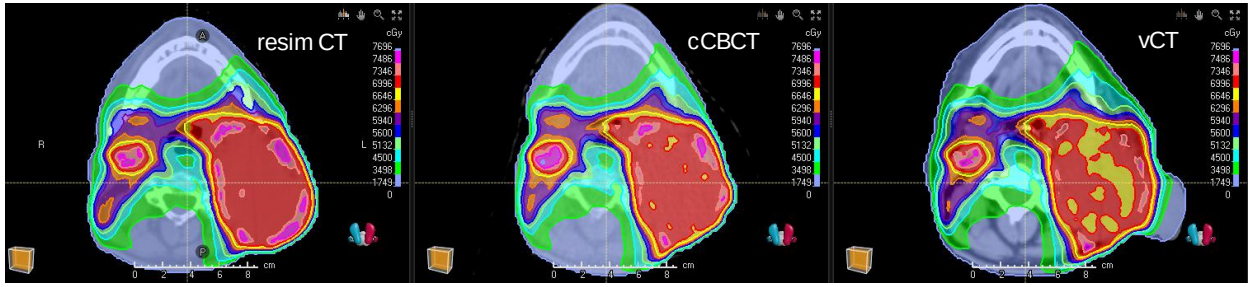

Fig 2. Dose distributions of the same plan calculated on different CT sets for the patient shown in Fig.1.

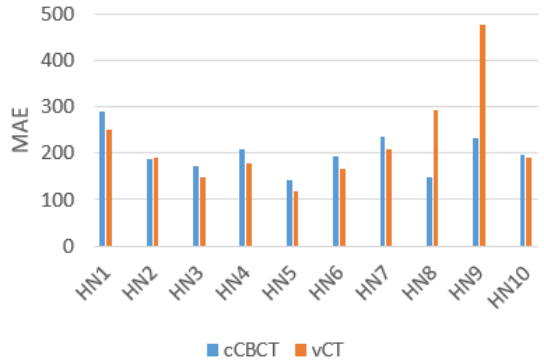

Fig 3. HU MAE for the 10 patients.

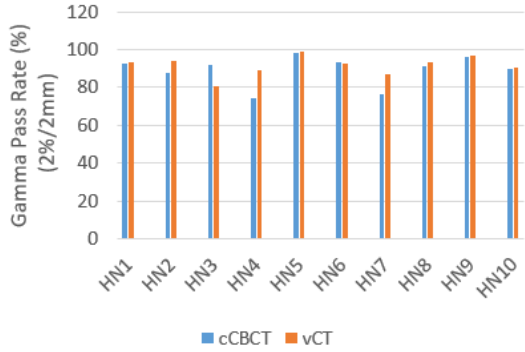

Fig 4. Gamma pass rate for the 10 patients.

CONCLUSIONS

For H&N cancer patients, especially those experiencing rapid anatomical changes, neither cCBCT nor vCT from RayStation in their current state provide sufficient anatomical or dosimetric accuracy to serve as a standalone dataset for generating a new adaptive treatment plan. Their role should be limited to an initial evaluation tool to trigger the decision for adaptive intervention.

ACKNOWLEDGEMENTS

This work was partially supported by American Cancer Society (grant no. RSG-22-030-01-CTPS).

Contact: rui.zhang@bcm.edu