

# Correlating daily CBCT 3D Gamma Density with Daily Volume and Dosimetric Changes in Head and Neck patients

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## INTRODUCTION

The radiotherapy of the HN patients is particularly challenging [1]. The patient anatomy changes significantly during radiation treatment due to multiple factors such as weight loss, tumor regression and parotid shrinkage. As such, a re-CT and a replan becomes a must in order to avoid the detrimental impact to the adjoining critical organs such as parotids, spinal cord and oral cavity. The best time to do a replan is always in question and is based on physician expertise in accessing the changes from cone-beam CT (CBCT) images.

## AIM

To identify correlation between Mobius3D CBCT gamma density values and organ volume and dose metrics.

Can we identify a 3D gamma density cut-off/threshold to predict right time for a replan?

## METHOD

Five HN patients with 165 daily CBCT images and at least one replan were retrospectively studied. The location of tumor site was consistent among the cohort. The patients were prescribed a total dose of 69.96 (PTV1), 66.0 (PTV2) and 59.4 Gy (PTV3) in 33 fractions. The daily registered CBCT images were sent to (1) Mobius CBCT (Varian Medical System, Palo Alto, CA) and (2) RayStation TPS (RayStation v7, RaySearch Laboratories, Sweden). A constant Gamma Criteria (0.2g/cc/3mm) was used in MobiusCB to find the daily changes in organ-specific 3D gamma density.

The daily CBCT images were deformably registered in RS using the Anaconda intensity-based algorithm [2]. The daily dose was computed on the CBCT's in the Dose-Tracking module of RS. Henceforth, the relevant dose-metrics based on the planning directives were extracted for comparison

## RESULTS

For each patient, the parameters used for correlations were

- (1) Daily changes in organ volume.
- (2) Daily changes in the dose metrics- $D_{95}$  and  $D_{99}$  for PTV1, PTV2 and PTV3 and organs-at-risk (OARs) ( $D_{mean}$  for parotids, oral-cavity and mandible,  $D_{0.03cc}$  for spinal cord and mandible) were evaluated.
- (3) Daily changes in organ-specific 3D gamma (0.2g/cc/3mm) calculated in MobiusCB to find the daily changes in organ-specific 3D gamma density.

The CBCT based daily organ-specific 3D gamma density varied significantly for a few OARs but stayed the same for others throughout the course of treatment [Figure 2]. No correlation was found for certain organs. A strong to moderate correlation was found between the organ-specific 3D gamma density in regard to volume changes, and changes in dose-metrics for parotids (0.8, -0.81), oral-cavity (0.71, -0.42); and PTV3 (0.65, -0.51). The volume changes for all the organs were strongly correlated to the dosimetric changes (-0.55 to 0.87).

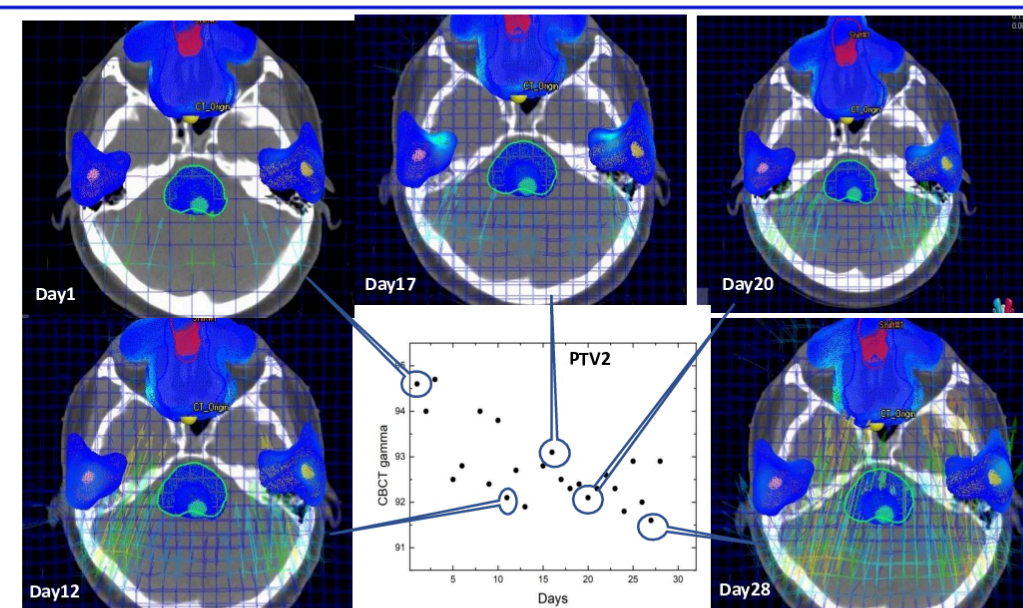


Figure 1: The daily changes in 3D gamma values (graph) and deformations in the CBCT images

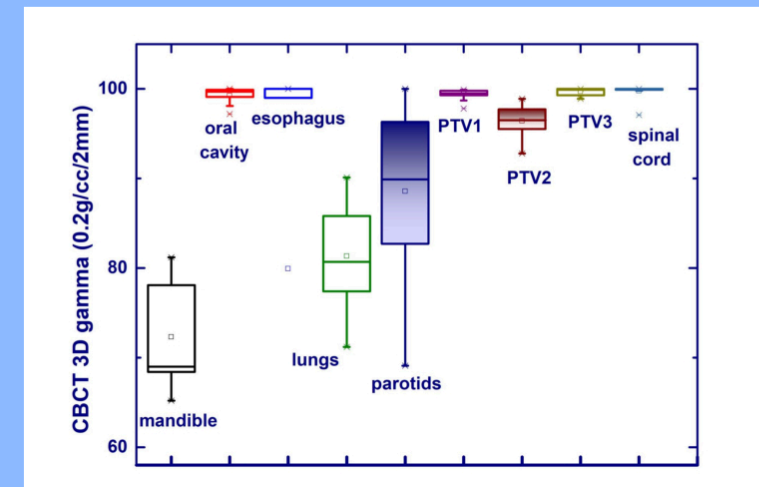
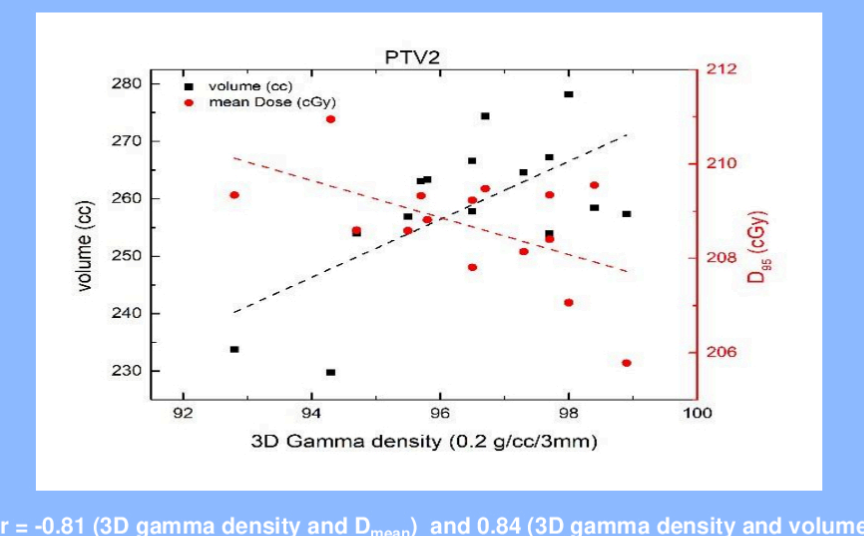
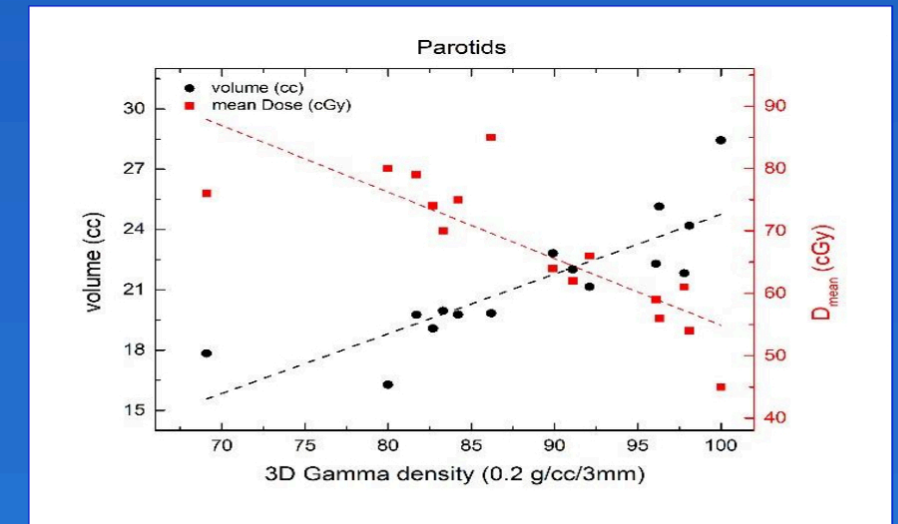


Figure 2: The 3D gamma density changes of different organs.



$r = -0.81$  (3D gamma density and  $D_{mean}$ ) and  $0.84$  (3D gamma density and volume)

Figure 3: The 3D gamma density changes in PTV2 with respect to changes in volume (cc) and  $D_{95}$  (Gy). Each data point represents pre-treatment CBCT acquired for a single patient



$r = -0.54$  (3D gamma density and  $D_{mean}$ ) and  $0.65$  (3D gamma density and volume)

Figure 4: The 3D gamma density changes in parotids with respect to changes in volume (cc) and  $D_{mean}$  (Gy). Each data point represents pre-treatment CBCT acquired for a single patient

## CONCLUSIONS

The organ-specific 3D gamma density analysis in MobiusCB (Varian Medical Systems) had a variable correlation with the predicted deformably mapped volume and dose metric changes. Further, investigations on a large patient cohort is needed to access the proposed question.

## REFERENCES

- 1) Adaptive Replanning Strategies Accounting for Shrinkage in Head and Neck IMRT, Int J Rad Oncol Biol Physics 75 (2009) 924-932
- 2) RayStation. Deformable Registration in RayStation (White paper) 2017

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