

## **Quantifying Weightloss with Boundary Detection in MATLAB using Verification Images of the Head and Neck – a Feasibility Study**

**Aim:** To develop a novel technique for quantifying weight loss in the treatment region for head and neck cancer (HNC) patients receiving external beam radiation therapy (EBRT), using boundary detection in both megavoltage (MVCT) and cone-beam computed tomography (CBCT) images, for use as a criterion for adaptive planning.

**Introduction:** During the course of treatment weight loss, tumor shrinkage and changes in tissue edema causes significant change in anatomy in treatment region and can lead to clinically significant dosimetric changes. Prior studies have attempted to correlate the volume change of the CTV and parotid glands to the patients' weight [1]. This observation is expected since weight loss may be a surrogate for tissue deformation and medial displacement of the parotid glands may place the parotids within the high dose target volumes [2]. Barker et al. have previously reported, using repeated CT scans throughout a 7-week radiotherapy course, a 70% reduction of the gross tumor volumes (GTV), together with the substantial changes in the anatomical structures including external neck contour modifications, medial shift of normal structures due to tumor shrinkage and weight loss, and parotid shrinkage [3].

Gradual anatomic changes requires careful clinical monitoring and frequent use of CT- based image-guided radiation therapy, which should determine variations necessitating new plans [1]. Techniques described in literature recommend clinical observed change in patient anatomy and weight loss, global weight change, or the measurement of skin separation either physically on the patient or in a repeat CT scan to trigger the need for adaptive planning. The use of skin contours in a repeat CT scan has been described in literature for serving as a surrogate of underlying anatomy changes [4].

In this study, the need for a repeat CT scan to quantify weight loss is avoided by utilizing on-board CBCT or MVCT images which are acquired for setup verification.

**Material and Methods:** This feasibility study comprised 8 patients, treated with intensity modulated radiotherapy (IMRT) or Tomotherapy for HNC.

**IMRT:** A CBCT scan was acquired prior to treatment to verify the patient setup position. This was done by comparing the digitally reconstructed radiograph (DRR) from the planning CT against the DRR generated from the CBCT. These CBCT images were saved offline.

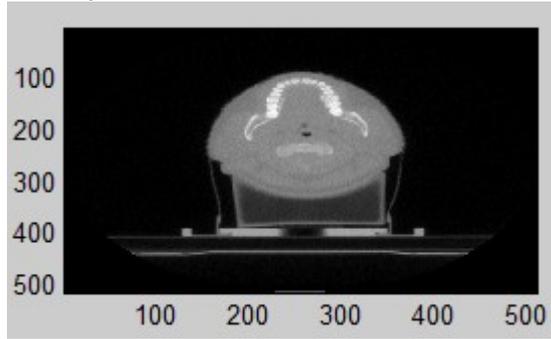
**Tomotherapy:** An MVCT was taken prior to treatment to correct for set-up errors. These MVCT images were saved offline as well.

The CBCT and MVCT images were accessed in MATLAB v.12 using the image processing toolbox for DICOM images. The CT cross-section at the level of interest was selected in the verification images. For this study, the CT slice of interest was at the level of C2 cervical vertebra as shown in Figure 1.

Each CT slice was converted to a binary black and white image using a threshold of 0.002 and 0.0055 for CBCT and MVCT respectively as shown in Figure 2. Contiguous white regions were labeled using a modified boundary detection function in MATLAB which was used to create outlines for each such region as shown in Figure 3. The area for the region corresponding to the head in the slice of interest was recorded. The percentage decrease in the cross-sectional area of the head region in the final day's verification image from the first day's verification image was recorded. Significant reduction in cross-sectional area was analyzed using paired t-test.

**Results:** The verification images of the 8 study patients were analyzed using the boundary detection code described. A total of twenty images were accessed in MATLAB. The change in cross-sectional area of the target region in HNC was found to be statistically significant with a p-value of 0.02.

First day of treatment



Last day of treatment

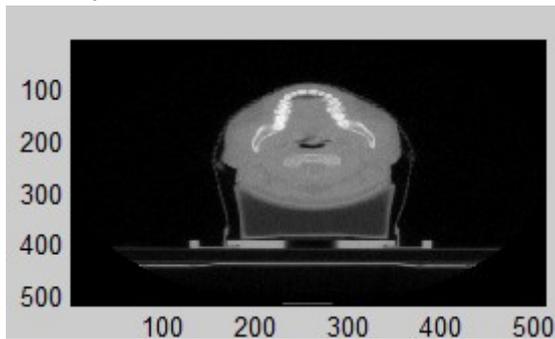


Figure 1. MVCT slice of interest at the level of C2 cervical vertebra

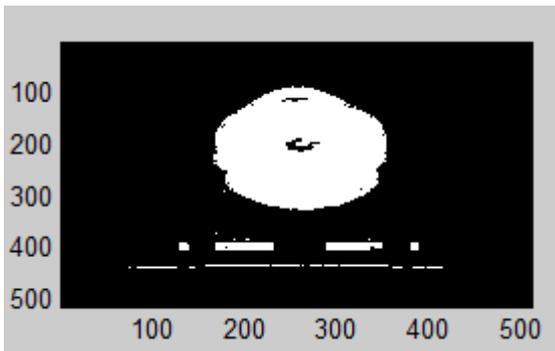
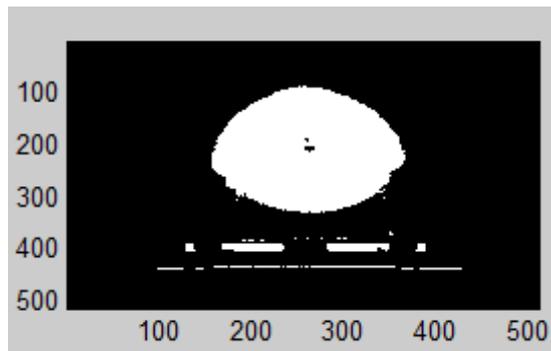


Figure 2. Binary black and white image generated using threshold of 0.0055 for MVCT images

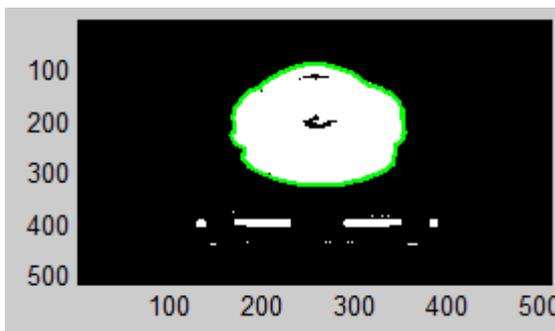
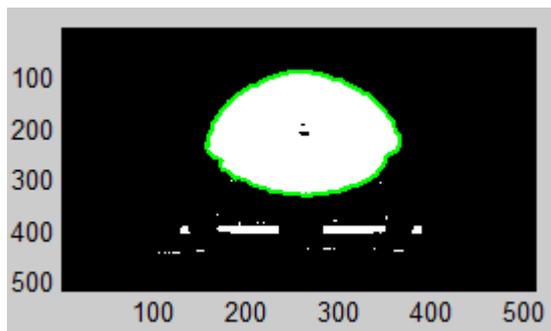


Figure 3. Contiguous white region corresponding to the head outlined using boundary detection

### Conclusion:

This study facilitates computation of inter-fraction weight loss in the treatment region for HNC patients undergoing EBRT. In verification scans where the number and location of selected slices are variable, computation of cross-sectional area is feasible alternative to volume. Currently this technique is being evaluated as a criterion for adaptive planning.

### References:

1. Bhide S, Weekly Volume And Dosimetric Changes During Chemoradiotherapy With Intensity-Modulated Radiation Therapy For Head And Neck Cancer: A Prospective Observational Study
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3. Barker JL Jr., Garden AS, Ang KK, et al. Quantification of volumetric and geometric changes occurring during fractionated radiotherapy for head-and-neck cancer using an integrated CT/linear accelerator system. *Int J Radiat Oncol Biol Phys* 2004; 59:960–970.
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