

Absorbed dose calculation based on CBCT data for head and neck cancer patients

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Conclusions

The dosimetric difference between the dose distributions for treatment plans calculated based on CT and CBCT data were minor.

This indicates that CBCT data could be a good candidate for quality control of synthetic CT data in an MRI only workflow for head and neck cancer patients.

Purpose and Aim

In a radiotherapy magnetic resonance imaging (MRI) only workflow, a synthetic CT (sCT) data set is generated from MRI data as a substitute to the standard computed tomography (CT) data. Since no CT scan will be acquired, no such data will be available for quality control (QC) of the sCT. It has, however, been suggested to use kV-cone beam CT (CBCT) data for this purpose [1].

The aim of this study was to evaluate the possibility to use CBCT data for QC of sCT data for head and neck (H&N) cancer by comparing H&N treatment plans calculated using CT and CBCT data, respectively.

Methods and Materials

Eleven patients with one CT and two CBCT data sets each, were evaluated. The CBCT data sets were acquired early in the treatment period in order to avoid anatomical changes, such as weight loss, that might occur. All CBCT data sets were deformable registered to the CT data prior to evaluation, remedying errors originating from repositioning and/or anatomical changes between imaging sessions.

The CBCT and CT data were adjusted to have the same field of view (FOV) in the longitudinal (head-foot) direction to achieve comparable data sets. A volumetric modulated arc therapy (VMAT) treatment plan was created based on the CT data for each patient. Treatment volumes, organs-at-risk (OAR) and treatment plan were transferred from the CT data to the deformable registered CBCT data, and the treatment plan was subsequently recalculated with the standard CT Hounsfield unit to relative electron density (HU-RED) conversion curve.

Dosimetric differences between the dose distributions for the treatment plans were calculated and evaluated by comparing dose-volume metric constrains.

Results and Discussion

Local dose difference in percent for dose-volume metric constrains when comparing the CT and mean of the CBCT based dose distributions for each patient can be seen in Figure 1. The baseline of zero, in the figure, represent no difference between the dose-volume metric constrains compared. The distance between the top and bottom of each box are the interquartile range. An outlier is defined as a value that is more than 1.5 times the interquartile range away from the top or bottom of the box.

The mean local difference for the mean absorbed dose to the clinical target volume (CTV) was $0.42 \pm 0.30\%$ with a minimum and maximum value of -0.26% and 0.80% respectively. The CTV $D_{98\%}$ criteria had a difference of $-0.13 \pm 1.67\%$ with a range of $[-4.10 \ 1.43]$ and CTV $D_{2\%}$ criteria a difference of $0.49 \pm 0.39\%$ $[-0.22 \ 0.95]$. The planning OAR volume (PRV) of the spinal cord had a difference of $0.36 \pm 0.46\%$ $[-0.35 \ 1.14]$ and the parotid right and left a difference of $0.26 \pm 0.55\%$ $[-0.72 \ 1.32]$ and $-0.09 \pm 0.52\%$ $[-0.99 \ 0.55]$, respectively.

The outliers for the CTV $D_{98\%}$ data are probably due to relatively large differences in placement of bolus material and/or positioning of the mandible between imaging sessions. This differences were challenging for the deformable image registration.

The parotid right outliers appeared due to evaluation of local dose difference in low dose metrics, where the small deviation in low dose metric resulted in a large percentage difference in local dose, leading to an outlier.

[1] J. M. Edmund *et al.*, *Acta Oncol. (Madr.)*, vol. 54, no. 9, pp. 1496–1500, 2015

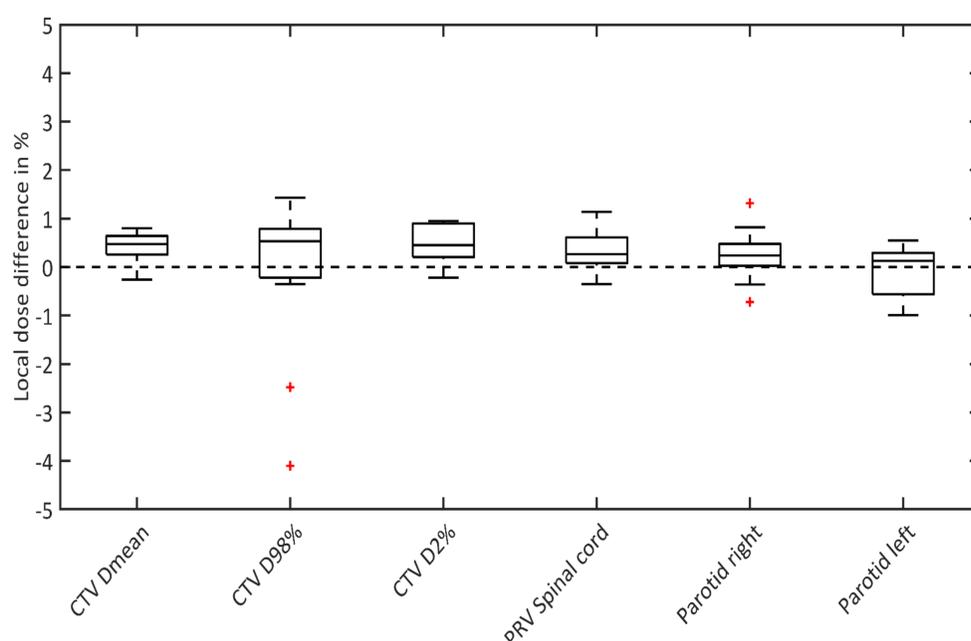


Figure 1. Difference in percentage between dose distributions calculated on CT and CBCT data sets. The dose-volume metric constrains were evaluated for CTV, PRV spinal cord and right and left parotid.

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