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Comparison of Reconstructed Virtual Monochromatic and Virtual non-contrast images from Dual Energy Computed Tomography with True non-contrast images for Head and Neck Cancer Patients

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1. Background-Aim

The use of Dual energy Computed Tomography (CT) with contrast medium provides the possibility of generating Virtual Monochromatic (VMC) and non-contrast (VNC) images.

For radiotherapy treatment planning : ⟶ VMC: are used for structure delineation by selecting the appropriate energy

⟶ VNC: are utilized for radiation treatment planning

Recent studies, showed differences of CT numbers for specific head's structures when compare the VNC and the True non-contrast (TNC) images[1,2].

The aim of this study is to conduct a quantitative comparison of tumour volume between TNC and VMC images and head structures' CT numbers of TNC and VNC for head and neck cancer patients.

2. Materials & Methods

- Six head and neck cancer patients who had previously undergone in radiotherapy were included in this study.

- For each patient two CT scans were performed using a 16-slice computed tomography unit (Somatom Sensation 16, Siemens, Forcheim, Germany):

  ⟶ Single energy Computed Tomography without contrast medium (TNC)

  ⟶ Dual energy Computed Tomography with contrast medium (VMC, VNC)

- The gross tumour volume (GTV) and third cervical vertebra (C3), mandible, buccal fat, parotid, carotid, submandibular gland, thyroid, int jugular vein, pedicle, and sternocleidomastoid were contoured by senior radiation oncologists through treatment planning system (Monaco 5.11, Elekta AB, Stockholm, Sweden).

2. Materials & Methods

- The volume (cm^3) of GTV was recorded for TNC and VMC images using the 3D Slicer image computing platform.

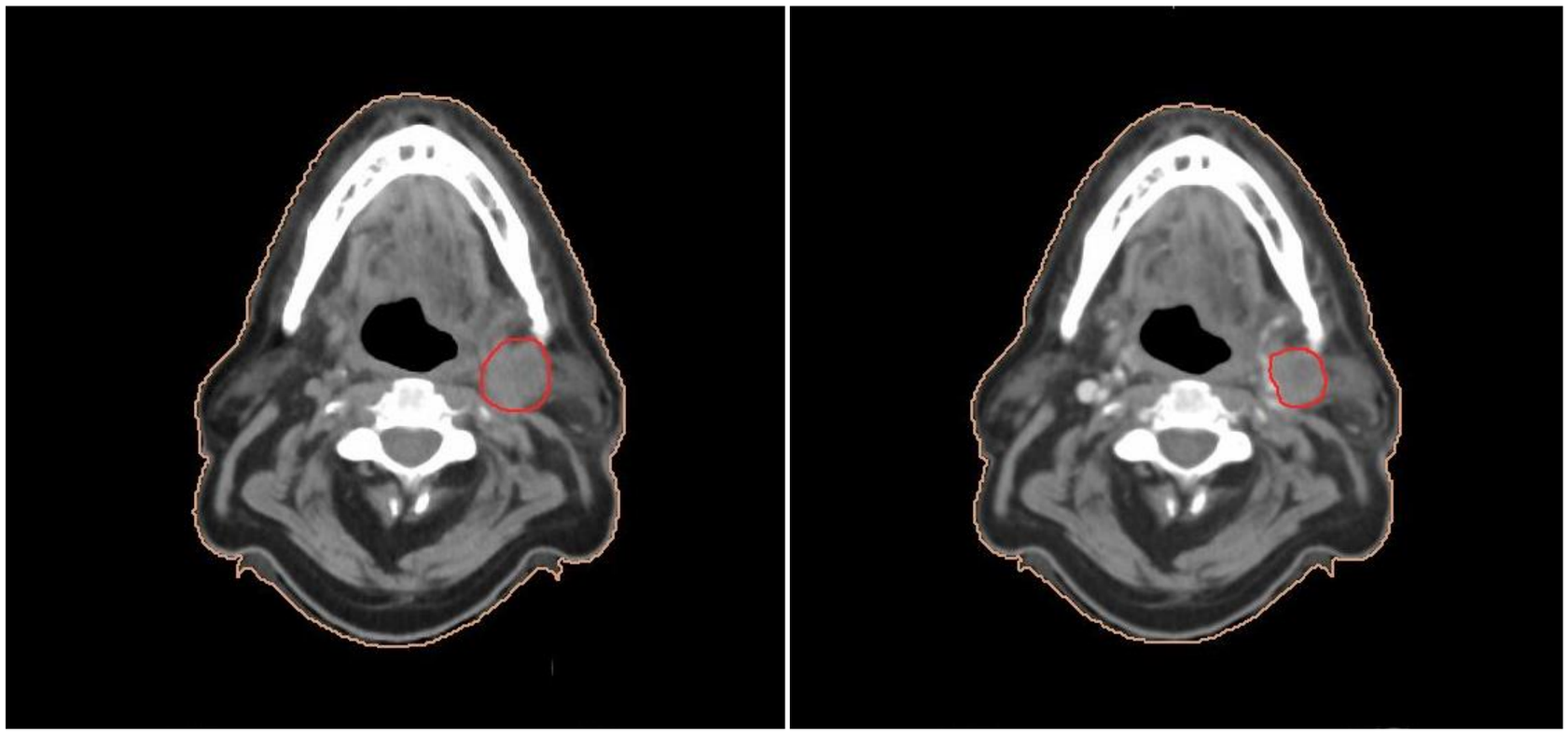


Figure 1. Computed tomography image with contoured GTV: TNC image (left); VMC image (right).

2. Materials & Methods

- The CT numbers of the examined structures were measured by drawing region of interest (ROI) in the central slice of the contoured structure. For each ROI, the mean and the standard deviation were recorded. All ROIs were placed at the same place and imaging level for TNC and VNC images.

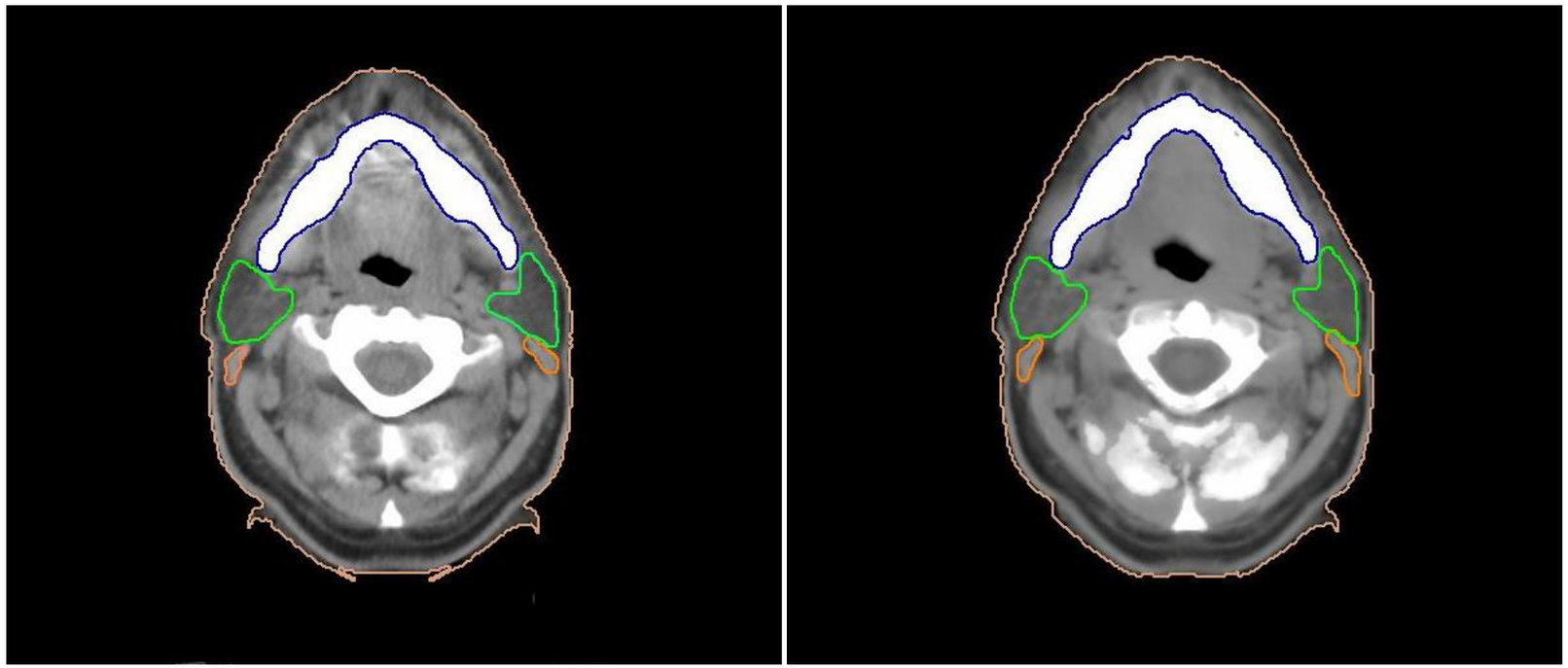


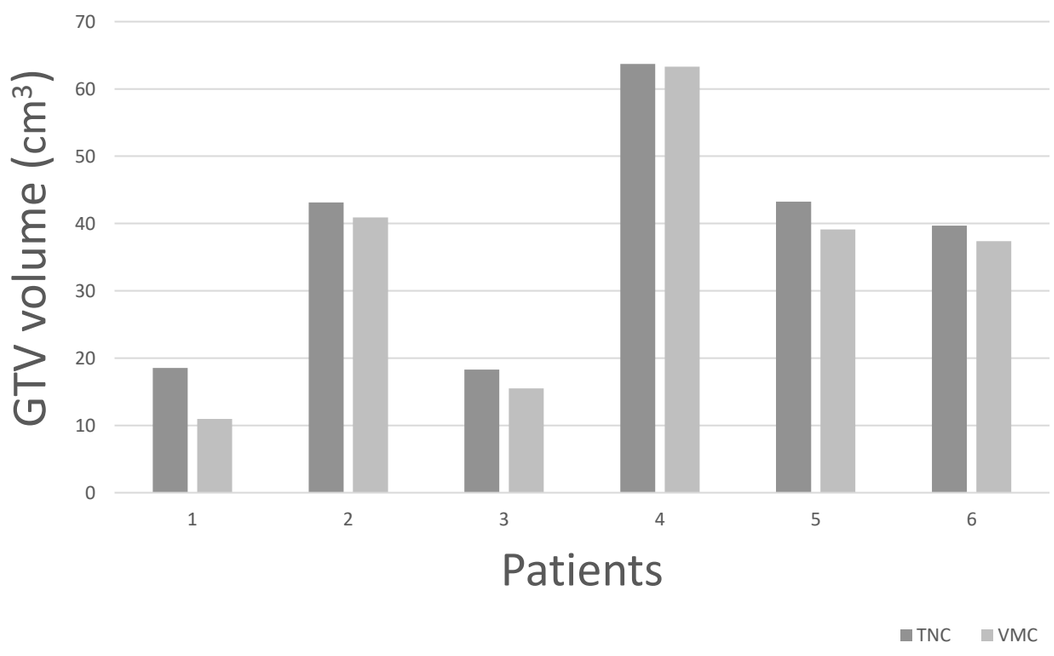
Figure 2. True non-contrast (left) and Virtual non-contrast (right) images with contoured structures: mandible (blue); parotid (green); sternocleidomastoid (orange).

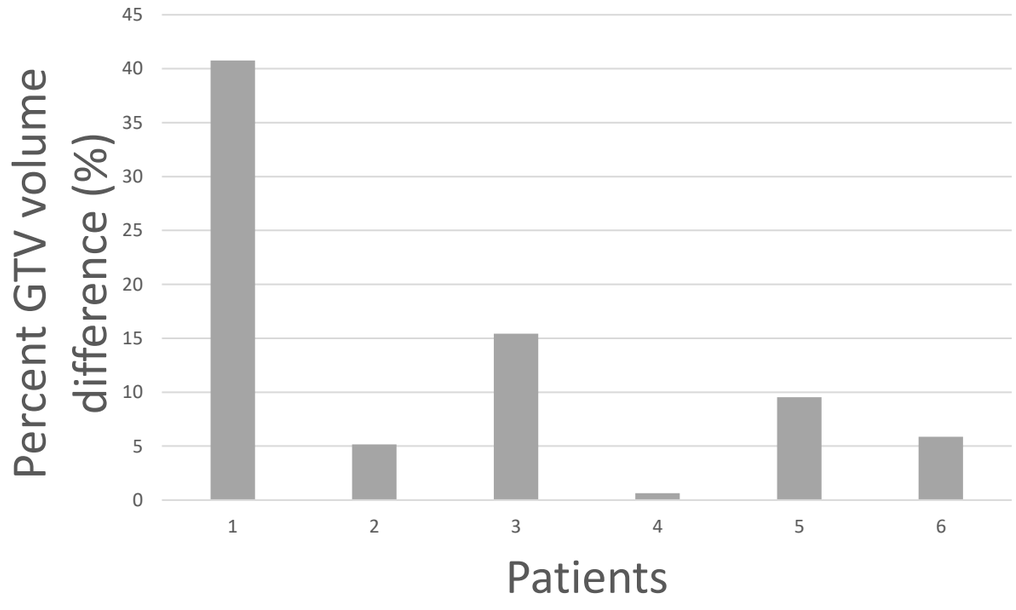
- Percent GTV volume difference and absolute CT number difference were calculated between the acquired images series.

3. Results

- Lower values of GTV volumes (cm^3) were recorded for VMC images than TNC images.

- The mean percent difference of GTV volumes as derived from TNC and VNC images was 13.8 ± 12.1 % (range: 0.6 - 40.8 %).





3. Results

- The mean absolute difference of CT numbers between the TNC and VNC images was 49 (range: 7 - 179).

- The highest absolute CT number difference was observed for 3C followed by pedicle and mandible.

Table 1. The mean and standard deviation of absolute difference of the head structures' means CT numbers as derived from True non-contrast and Virtual non-contrast images.

Structures	means ± stdv
Cervical vertebra (3C)	178.8 ± 68.7
Mandible	74.4 ± 47.9
Buccal fat	9.0 ± 4.5
Parotid	8.5 ± 4.7
Carotid	12.3 ± 6.8
Submandibular gland	8.6 ± 6.9
Thyroid	35.0 ± 17.6
Int jugular vein	8.3 ± 4.6
Pedicle	146.1 ± 179.2
Sternocleidomastoid	7.4 ± 7.1

4. Conclusions

- For GTV volume, the VMC images recorded lower values than the TNC images.
- The structure delineation tend to be more accurate using the VMC images.
- The presented preliminary results demonstrate that the CT numbers in VNC images are similar with those in TNC images for most of the structures.
- Further investigation is required to determine the dosimetric impact of the significant differences for C3 and pedicle structures.

5. References

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