1. Purpose

Atlas-based segmentation can be used to segment the critical structures for conformal radiotherapy of the head and neck region. The use of a single unspecific average atlas proved to provide promising results but it still has difficulties to cope with the high variability in the head and neck region. Using an atlas that is specifically adapted to the patient's anatomy allows the registration to perform better and is likely to improve the segmentation accuracy. To this end, we propose here to define and use atlases that are adapted to the location of the primary tumor and the nodal staging of the patient. This enables taking into account the impact of the tumor on the Clinical Target Volume and on the deformation of the critical structures.

2. Methods

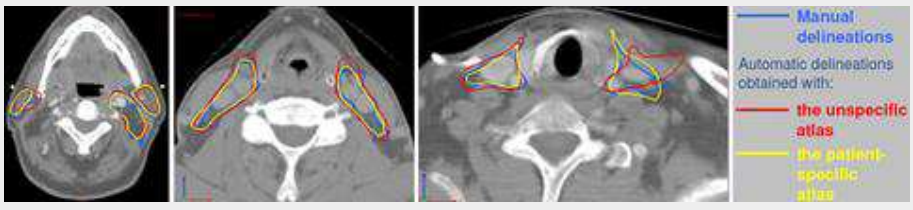
We used a database of 105 manually delineated CT images of the head and neck region. This database was clustered into 20 homogeneous sub-groups, taking into account the nodal staging (N0-N1 or N2) and the location of the primary tumor (hypopharynx/larynx/nasopharynx/oropharynx/oral cavity and left/right side). Then, an average atlas (average image and its associated average segmentation) was built for each sub-group. Grouping together patients as described above enables reducing the variability within each sub-group, and therefore, improving the quality of the registration in the atlas building process.

3. Results

The proposed method was evaluated by clinicians from two different clinical centers on 6 patients with cancer of the oropharynx (stage N2). For each of these 6 patients, two automatic segmentations were compared to the manual segmentation: (1) the automatic segmentation obtained by using the patient-specific atlas of the appropriate sub-group (either oropharynx/N2/right side or oropharynx/N2/left side), (2) the automatic segmentation obtained by using the unspecific atlas built from the entire database. Both atlases were non-linearly registered with the patient image and the atlas contours were propagated onto the patient image and compared to the manual segmentation.

Qualitative results of segmentation using both atlases are presented in the figure.

Qualitative results of segmentation using the patient-specific atlas (yellow) and the unspecific atlas (red), compared to the manual segmentation (blue).



For each patient, the clinicians first gave scores to both automatic segmentations based on their qualitative evaluation. These scores range between 1 and 5 (1=bad, 5=excellent). In average over the 6 patients, the patient-specific atlas got an average score of 3.2 (standard deviation=0.2) whereas the unspecific atlas got an average score of 2.7 (standard deviation=0.5), which shows the visual improvement.

Dice indexes were also computed for both automatic segmentations for each patient, and then

averaged over the 6 patients. The patient-specific atlas proved to significantly improve the average Dice (mean=0.76, standard deviation=0.09) in comparison with the unspecific atlas (mean=0.70, standard deviation=0.15).

4. Conclusions

The patient-specific atlases described above proved to improve the segmentation accuracy on 6 patients with cancer of the oropharynx (stage N2). Further evaluation on patients with other tumor locations and other nodal stages is in progress.

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