Atlas-based segmentation for delineating the locoregional node levels during breast radiotherapy

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Introduction and purpose
Proper multi-atlas automated delineation can streamline clinical routine only when the proposed volume determination reasonably approximates the manual delineation. In this investigation we aimed to evaluate the automatic atlas-based segmentation of supraclavicular and level 3 lymph nodes for loco-regional irradiation of breast cancer. Further analysis were performed on the final plan’s dose coverage to the automated clinical target volume.

Material and methods
Between June and September 2015 five consecutive breast cancer patients with clinical indication for loco-regional irradiation were selected. Pre-defined breast delineation atlas of Mirada RTx (version 1.6.2, Mirada Medical, Oxford, United Kingdom) software were used to generate automated clinical target volumes (CTVauto) including the supraclavicular and the axillary level 3 lymph nodes. Responsible radiation oncologist delineated the reference CTV (CTVref) for each individual patients as well. Comparison metrics of Dice similarity (DI) and commonly contoured volume (CCV) were used. Furthermore the CTVauto was expanded with 1,2,3,4 and 5 mm uniform margin consecutively followed by an evaluation of the volumetric coverage of CTVref. Finally clinical plans were created expanding CTVref with 5 mm uniform margin using either direct antero-posterior beam or multi-beam IMRT. Dose coverage of the 95% of prescribed dose (V95) were compared for both CTVs.

Results and discussion
The average CTVref was 35.1 cc (Standard deviation = 10.2), while for the CTVauto 42.1 cc (SD = 12.1). Mean DI and CCV were 0.73 (SD: 0.26) and 0.72 (SD: 0.28) respectively. Expanding the CTVauto up to 5 mm in 1 mm increments covered the CTVref with 53.9%, 77.9%, 88.1%, 90.9%, 92.7% and 95.7% respectively. (Figure 1). For two patients single direct ante-posterior (AP) beam were used for the loco-regional treatment, while for the other three cases 6 beam IMRT were used. Average V95% dose coverage of CTVref was 98.5% (SD: 3.0) which lowered to 92.0% (SD: 9.1%) for CTVauto. For the two patient with single AP field the CTVref were 93.0% and 99.5%, which dropped to 79.8% and 99.4% for CTVauto. The multi-beam IMRT cases showed 100%, 99.9% and 99.8% CTVref_V95 and 100%, 88.5% and 94.0% CTVauto_V95.

Conclusions
CTV delineation using an atlas-based auto-segmentation shows promising results even in a small complicated volume delineation such as the loco-regional lymph nodes of breast. Further improvement of the delineation accuracy is expected by adding more cases to the initial multi-atlas (with 3 provided cases).

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