Novel Semiautomatic Real-time CT Segmentation Tool and Preliminary Clinical Evaluation on Thermally Induced Lesions in the Liver

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PURPOSE

Quantitative, image-based assessments of lesion volume and shape improve the correctness of follow-up reports and potentially influence therapeutical decisions but are usually laborious and time-consuming. The goal was to assess the clinical feasibility of a novel real-time CT segmentation tool on thermally induced liver lesions.

METHOD AND MATERIALS

CT data were available from patients with unresectable, primary liver tumors that underwent CT-guided radiofrequency ablation at our institution (MX8000/Brilliance, Philips, NL; StarBurst, Angiodynamics, NY). Two radiological readers retrospectively segmented 12 lesions in CT images using a manual contouring tool under MeVisLab (Bremen, GER). One independent reader used a novel real-time segmentation tool derived from a previous batch application for the brain [1, 2, 3] and prostate [4]. The algorithm starts with a spherical template of 3D nodes and edges outside the lesion [5]. Nodes are continuously adapted by sending rays from a user-defined seed point inside the lesion through the surface of the polyhedron [6]. Key parameters like stiffness and number of nodes were defined on a training dataset. The user can visually explore and modify the 3D result on the fly. The Dice Similarity Coefficient (DSC) [7] was used to measure the agreement of two segmentations. Differences in manual processing times t_P and measured lesion volumes V_L were analyzed by two-sided paired t-tests (α=0.05) using SPSS 20 (IBM, NY).

RESULTS

Measured V_L was 10.0 - 122.6 ml (mean 36.0 ml) and t_P was 0:48 - 8:16 min (mean 3:13 min). Differences in V_L (mean 0.3 ml, p=0.639) and t_P between both readers (mean 0:22 min, p=0.200) were not significant and the mean DSC was 89 % (82 - 93 %). Differences between automatically and manually segmented (mean of both readers) V_L were somewhat larger but not significantly (mean -3.0 ml, p=0.305). The corresponding mean DSC was 77 % (68 - 85 %). In ten cases, the seed point or key parameters were slightly refined, which took less than 1 min, and in two cases, no further interaction was required.

CONCLUSION

Reliable estimates of lesion volumes and shapes could be obtained on-the-fly by using a novel real-time segmentation tool in patients undergoing radiofrequency in the liver.

CLINICAL RELEVANCE/APPLICATION

Lesion volume and shape, potential factors for therapeutic decisions, can be reliably estimated and monitored with a real-time CT segmentation tool with immediate visual feedback in under a minute.

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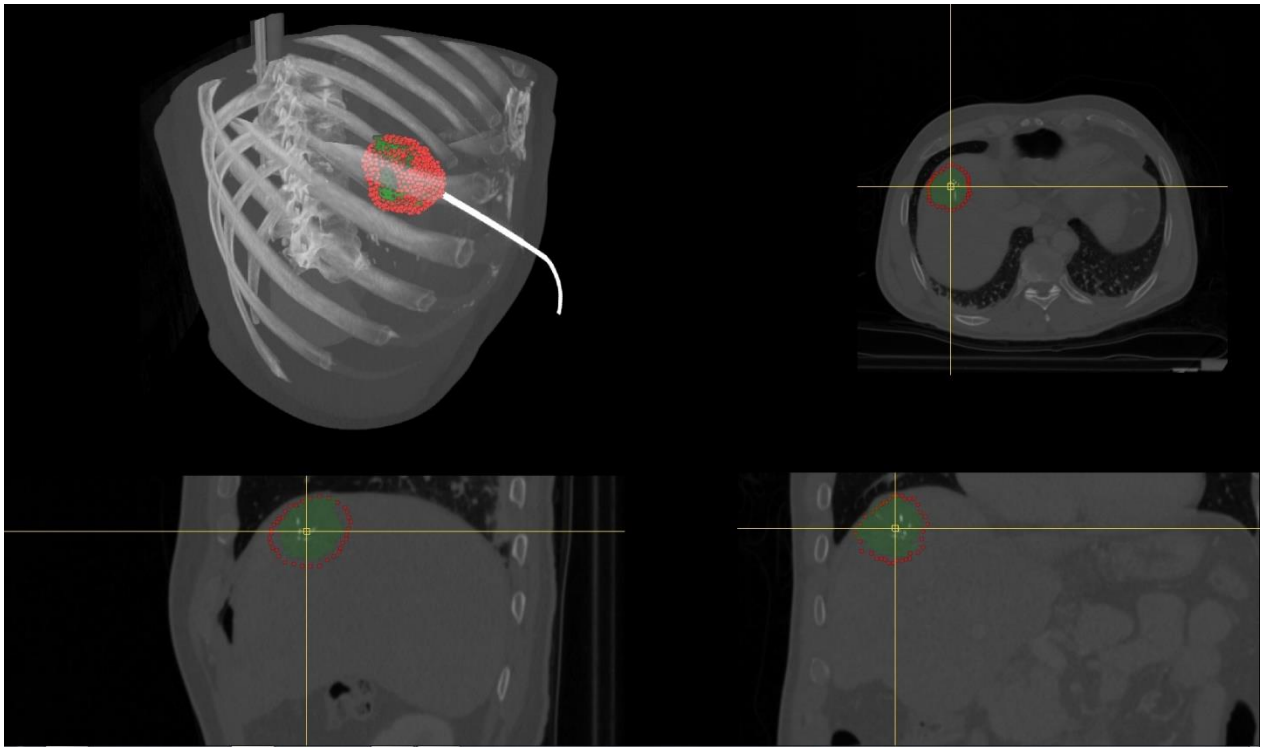

Figure – Direct comparison of a manual (green) and an automatic (red) segmentation. The upper left window shows both segmentation results as 3D masks superimposed in the original dataset. The upper right, lower left and lower right windows present direct comparisons between the manual and the automatic segmentation on an axial, coronal and sagittal slice, respectively. The yellow cross points to the location of the manual seed point that has been placed by the user for the graph construction.

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