Quantitative Volumetric Assessment of CT-guided Ablation Treatments for Colorectal Liver Metastases

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***Abstract*— In image-guided percutaneous ablations of liver tumors, the technical intra-procedural success of the treatment is defined by achieving complete tumor destruction plus a circumferential ablation margin of at least 5 mm. In the current setting, the ablation success is visually evaluated by an interventional radiologist who compares the differences between the pre- and post-ablation images. To address this limitation, we have developed an image-based analysis pipeline to compute radiomics for evaluating the volumetric coverage of the ablation. In this work, we present preliminary results after applying the radiomics extraction pipeline to a retrospective cohort of 102 patients that were treated with image-guided percutaneous microwave ablations for colorectal liver metastases.**

I. INTRODUCTION

Percutaneous thermal ablation is a minimally invasive technique generally performed under image-guidance based on CT, MRI or ultrasound. The patients undergoing this treatment benefit from a drastically improved quality of life, since they go home the next day and repeat the treatment when necessary. The ablation treatment has not yet taken over surgical resection due to the high local tumor progression (LTP) rates, which in these cases reach up to 48% [1]. It has been shown that the risk of LTP can be reduced by achieving complete coverage of the tumor including at least a 5 mm ablation margin. In the clinical routine, the ablation is visually assessed by the expert eye of the radiologist which is a subjective technique limited by repeatability and exact numerical quantification.

To address the current limitations in CT-guided ablations, we developed an image-based quantitative analysis pipeline to assess the volumetric ablation coverage using radiomics. We are currently evaluating this analysis pipeline on the MAVERRIC patient cohort [2].

II. METHODS

A software tool for semi-automatic segmentation of tumors and ablations has been developed and integrated into a commercially available navigation system for percutaneous ablations. The seeding point for the semi-automatic Fast-Marching algorithm is taken from the target point of the ablation probe. Based on the DICOM segmentation images, several radiomics which include volumes, diameters, intensity levels and surface distances are computed. The surface distance was calculated as the Euclidean distances between each surface voxel of the tumor and ablation w.r.t the percentage of tumor surface covered and used to evaluate the ablation coverage and ablation margin.

The study included 102 patients with 1-5 tumors < 31 mm in diameter, treated with thermal microwave ablation under CT-image guidance. The post-operative scan for evaluating the ablation success was taken immediately after ablation was performed. In total, 177 tumors were treated.

III. RESULTS

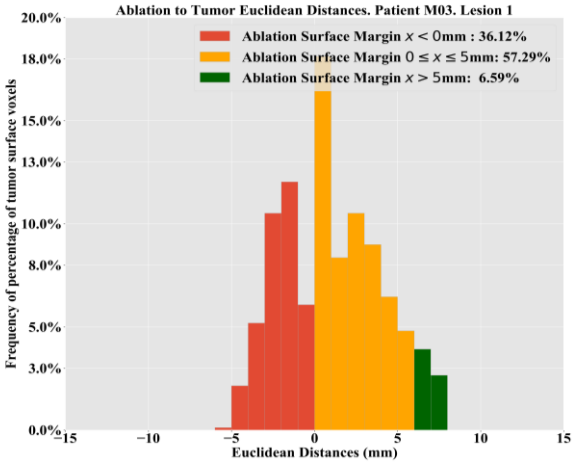

Figure 1 Percentage of tumor surface covered by ablation margins.

Fig. 1 depicts one result from the radiomics analysis pipeline showing an insufficiently treated tumor. The histogram employs a traffic-light color scheme relating to the ablation margin convention. This tumor had an LTP at the patient's 6-months follow-up.

IV. DISCUSSION & CONCLUSION

This work proposes a volumetric image-based quantitative analysis for measuring the technical success of the ablation treatment. This metric, together with other radiomics, could enable a precise measurement of ablation shape, size and margins that could be utilized to identify patients with increased risk of LTP. Eventually, this method might provide an important intra-operative feedback that would allow re-ablations in the same treatment session.

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REFERENCES

[1] X. Wang *et al.*, "Margin Size is an Independent Predictor of Local Tumor Progression After Ablation of Colon Cancer Liver Metastases," *Cardiovasc. Intervent. Radiol.*, vol. 36, no. 1, pp. 166–175, Feb. 2013.

[2] "Microwave Ablation Versus Resection for Resectable Colorectal Liver Metastases - Full Text View - ClinicalTrials.gov." [Online].