AB011. Quantification of thymic epithelial tumor volumes through deep learning

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Background: Measuring the treatment response in patients with thymic epithelial tumors (TETs) remains a challenging task. Currently, RECIST v1.1, which employs simple long and short-axis measurements, is utilized. However, pleural lesions are often curvilinear and thus the accuracy of simple linear measurements is questionable. The International Thymic Malignancies Interest Group has proposed modifications to the standard RECIST criteria to address this issue. Here, we propose an innovative method for automatic volumetric measurement based on U-Net, a convolutional neural network that facilitates the automatic segmentation of TETs, slice-by-slice, within a given region-of-interest (ROI) to compute 3D volume measurements. This technique replaces arduous manual and ambiguous segmentation efforts with a simple 3D ROI selection and produces consistent and reproducible volumetric segmentations.

Methods: Sixty-three CT scans that included a total of 141 tumors from 45 individuals enrolled in an ongoing trial (NCT02146170) were used to train the model. Each scan was manually annotated slice-by-slice and carefully inspected by thoracic radiologists. TETs were characterized by their general location within the chest cavity: lung parenchyma, pleura, or mediastinum. Results from the training set were compared against a separate validation set comprised of 22 CT scans from 15 patients with a total of 49 tumors. Performance was evaluated using the dice similarity coefficient (DSC) which quantifies the volumetric accuracy, producing scores of 0 (least similar) to 1 (most similar).

Results: Patient characteristics include median age: 55 (range, 32–75) years; females: 29; thymoma: 25; and thymic carcinoma: 35. U-Net analysis yielded an overall DSC of 0.59±0.17 [lung parenchymal tumor: 0.60±0.09, pleura tumor: 0.68±0.15, mediastinum tumor (not lymph node): 0.57±0.19]. DSC was 0.6±0.13 for thymic carcinoma, 0.48±0.03 for 7 B2 thymomas and 0.59±0.29 for 10 B3 thymomas. The complex appearance of TETs resulted in outlier DSCs.

Conclusions: Our preliminary results provide compelling evidence of the feasibility of utilizing deep learning to automatically quantify TET volumes. Similar approaches have shown high success in solitary nodule segmentation; however, the complicated anatomical presentation of TETs presents a unique challenge. Expansion to larger datasets is ongoing to improve the algorithm's accuracy.

Keywords: Deep learning; thymoma; thymic carcinoma

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://med.amegroups.com/article/view/10.21037/med-23-ab011/coif). NL reports support from NIH Intramural Research Program for travel and meeting expenses. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). All individuals included in this study are enrolled in the following ongoing clinical trials: NCT02146170, NCT03076554, NCT04417660 and NCT05104736, and provided written informed consent for

the use of their clinical data and CT results.

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