AB012. Automated histologic subtyping of thymic epithelial tumors with deep learning

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Background: Rare tumors are diagnostic challenges for pathologists. Thymic epithelial tumors (TETs) are heterogenous and their treatment strategies vary according to histological subgroup. Previous work has shown that a second pathological opinion may result in a change in diagnosis for more than half of cases, with a potential treatment shift in 44%. The aim of this study is to assess the feasibility of using artificial intelligence and deep learning to classify TETs, which could be used to help improve pathologist diagnostic consistency for these challenging tumors.

Methods: Digital diagnostic hematoxylin and eosin (H&E) stained slides of tumors for 103 patients with thymoma type A, AB, B1, B2, and B3 were downloaded from The Cancer Genome Atlas (TCGA). An Xception-based deep convolutional neural network model was trained on slide images at 10× magnification to predict histologic subtype as an ordinal variable in three-fold cross-validation. Hyperparameters were taken from previously published experiments, and no additional hyperparameter tuning was performed to reduce the risk of overfitting. Validation predictions from each cross-fold were aggregated and compared between groups using analysis of variance (ANOVA) and one-sided *t*-tests with Bonferroni correction for multiple comparisons. Model activations at the post-convolutional layer for validation images in the first cross-fold were visualized with uniform manifold approximation and projection (UMAP) dimensionality reduction to better understand the spatial relationship between learned image features.

Results: Deep learning predictions among the TET subtypes were significantly different by ANOVA (P<0.0001) and correlated with the ordinal labels (R-squared =0.39). Thymoma A and AB subtypes were distinguished from both B1 and B2/B3 (P=0.023 and <0.001, respectively), and B1 tumors were distinguished from B2/B3 (P=0.011). Analysis of post-convolutional layer activations revealed an axis of transition through the ordinal variables, providing evidence that the deep learning model learned image features on a morphologic spectrum.

Conclusions: This is the first example in TETs that deep learning can discriminate between TET histologic subtypes using digital H&E slides. We aim to further validate the algorithm with a multi-institution dataset from centers of expertise to improve the ability to distinguish thymoma subtypes.

Keywords: Deep learning; computational pathology; thymic epithelial tumor (TET)

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Footnote

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