



THYMIC MALIGNANCIES: THE GREAT FORGOTTEN TUMORS THE IMPORTANCE TO DEFINE THEM CORRECTLY

William D. Travis, M.D.
Dept of Pathology, Memorial Sloan Kettering Cancer Center

Thymic epithelial tumors including thymoma and thymic carcinoma are the most common thymic tumors that concern clinicians. All thymomas are regarded as malignant tumors. Accurate diagnosis requires good familiarity with the diagnostic criteria in the new 2021 WHO Classification.^{1, 2}

In the 2021 WHO Classification, the following thymoma subtypes are recognized: Thymoma, NOS, Thymoma type A (including atypical subtype), AB, B1, B2, and B3 as well as micronodular thymoma with lymphoid stroma, metaplastic thymoma and lipofibroadenoma. ^{1, 2} The spectrum of thymomas from A to B3 generally represent a spectrum of histologic grade from low (A and AB) to high (B3).

In addition, the following thymic carcinoma subtypes are recognized: Squamous carcinomas: (Squamous cell carcinoma, NOS, basaloid carcinoma, Lymphoepithelial carcinoma); Adenocarcinoma (adenocarcinoma, NOS, low-grade papillary adenocarcinoma, thymic carcinoma with adenoid cystic carcinoma-like features, adenocarcinoma, enteric-type); Adenosquamous carcinoma; NUT carcinoma, Salivary gland-like carcinomas (mucoepidermoid carcinoma, clear cell carcinoma, sarcomatoid carcinoma, carcinosarcoma), Undifferentiated carcinoma, and Thymic carcinoma, NOS. ^{1, 2}

While most of these tumors can be readily diagnosed on H&E stains, the diagnosis of some tumors benefits by immunohistochemistry.^{1, 2} Subtyping of thymomas can benefit by pancytokeratin for the thymic epithelial tumor cells and TdT to determine the quantity of immature thymic lymphocytes in the stroma. The latter is most useful in the distinction of some type AB thymomas from type A thymomas. TdT lymphocytes are also lacking in thymic carcinomas. In epithelial predominant tumors with a differential diagnosis of B3 thymoma or atypical Type A thymoma, positive staining for CD5, CD117 and POU2F3, can help support the diagnosis of thymic carcinoma. In poorly differentiated tumors, particularly in young patients, immunohistochemistry with the NUT antibody can help to confirm the diagnosis of NUT carcinoma.

The classification of thymomas and thymic carcinomas is supported by genetic studies.³ In a study by the TCGA it was shown that type A and AB thymomas are genetically different from the type B1-B3 thymomas. In addition thymomas are clinically and genetically very different from thymic carcinomas.³ Type A and AB thymomas are frequently associated with GTF2I mutations in contrast to type B thymomas and thymic carcinomas are associated with TP53 mutations. In addition, YAP1-MML2 translocations were found in metaplastic thymomas and KMT2A-MAML2

translocations can be found in pretreated aggressive type B2 and B3 thymomas and in combined thymic carcinoma/B3 thymoma.^{1, 2}

Thymic neuroendocrine tumors are also separated into 1) Neuroendocrine tumors which includes typical and atypical carcinoid as well as 2) Neuroendocrine carcinomas including small cell carcinoma (with combined small cell carcinoma) and Large cell neuroendocrine carcinoma.^{1, 2} These tumors are diagnosed according to the same criteria as in the 2015 WHO classification.⁴ An emerging observation is the occurrence of tumors with carcinoid morphology that have elevated mitotic counts or Ki-67 indices in excess of what would be expected in thymic atypical carcinoids. These tumors generally correspond to the tumors that have been classified as G3 neuroendocrine tumors in other organs such as the pancreas.^{1, 2} However, these tumors need to be better defined and insufficient data was available to formally recognize such tumors in the 2021 WHO Classification.

References

1. WHO Editorial Board. WHO Classification of Tumours: Thoracic Tumours. 5th ed. Lyon (France): International Agency for Research on Cancer; 2021.
2. Marx A, Chan JKC, Chalabreysse L, Dacic S, Detterbeck F, French CA, Hornick JL, Inagaki H, Jain D, Lazar AJ, Marino M, Marom EM, Moreira AL, Nicholson AG, Noguchi M, Nonaka D, Papotti M, Porubsky S, Sholl LM, Tateyama H, Thomas de Montpréville V, Travis WD, Rajan A, Roden AC, Ströbel P. The 2021 World Health Organization Classification of Tumors of the Thymus and Mediastinum: What's new in thymic epithelial, germ cell and mesenchymal tumors? *J Thorac Oncol* 2021, epub ahead.
3. Radovich M, Pickering CR, Felau I, Ha G, Zhang H, Jo H, Hoadley KA, Anur P, Zhang J, McLellan M, Bowlby R, Matthew T, Danilova L, Hegde AM, Kim J, Leiserson MDM, Sethi G, Lu C, Ryan M, Su X, Cherniack AD, Robertson G, Akbani R, Spellman P, Weinstein JN, Hayes DN, Raphael B, Lichtenberg T, Leraas K, Zenklusen JC, Fujimoto J, Scapulatempo-Neto C, Moreira AL, Hwang D, Huang J, Marino M, Korst R, Giaccone G, Gokmen-Polar Y, Badve S, Rajan A, Ströbel P, Girard N, Tsao MS, Marx A, Tsao AS, Loehrer PJ. The Integrated Genomic Landscape of Thymic Epithelial Tumors. *Cancer Cell* 2018;33:244-58.e10.
4. Travis WD, Brambilla E, Burke A, Marx A, Nicholson A. WHO Classification of the Tumours of the Lung, Pleura, Thymus and Heart. 4th Edition ed. Lyon: IARC Press; 2015.