RAPID OPTICAL CYTOLOGY FOR THYROID CANCER DETECTION

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Thyroid cancer is the tenth most common cancer globally. Its incidence rate is increasing at an average of approximately 500,000 new cases annually. The standard of care for detecting thyroid cancer is fine-needle aspiration cytology, whose diagnostic accuracy ranges between 60.2% and 68.8%. Moreover, this diagnostic procedure is lengthy and subjective as it requires visual assessments of cytomorphology. Therefore, a robust, accurate, and faster method for reducing uncertainty of cytopathological evaluation would be invaluable.

Recently, we have developed an accurate quantitative approach to diagnosing thyroid cancer using fluorescence polarization imaging [1]. However, its clinical implementation requires reduction of the time required for sample preparation and data analysis. To remedy these shortcomings, we are combining a newly developed rapid sample preparation protocol with a novel automated image analysis pipeline.

In this talk we will present the first results yielded by our rapid staining and imaging of thyroid cytology samples for cancer diagnosis using fluorescence polarization (Fpol) of methylene blue (MB). The rapid sample preparation technique was implemented using thyroid cells obtained from excess, freshly excised, de-identified surgical specimens. So far, we have imaged and analyzed 27 samples, including 9 obtained from cancerous tumors, 9 from benign lesions, and 9 from normal thyroid tissues. Results demonstrate that rapid MB Fpol cytology provides a reliable and accurate method to detect thyroid cancer at the cellular level. In parallel, we are developing a deep learning model for automated cell segmentation which reduces total segmentation time to approximately 15 seconds. This model is trained to overcome variations in image quality, cell morphology, and staining. Most importantly, implementation of the automated cell segmentation and Fpol processing approach eliminates the need for an imaging expert, which further reduces the time for diagnosis and technical skill requirements for the potential users.

When fully developed, the proposed automated quantitative approach to thyroid cancer detection may provide an accurate and objective biomarker for thyroid cancer, improve diagnostic accuracy of cytopathology, and decrease the number of lobectomy and near-total thyroidectomy procedures.

[1]. P.R. Jermain, A.H. Fischer, J. L. Muzikansky, A.N. Yaroslavsky. Fluorescence Polarization Imaging of Methylene Blue Facilitates Quantitative Detection of Thyroid Cancer in Single Cells. Cancers. 14(5):1339 (2022)