Proceedings of the 5th World Congress on Electrical Engineering and Computer Systems and Sciences (EECSS'19)
Lisbon, Portugal – August, 2019
Paper No. ICBES 108
DOI: 10.11159/icbes19.108

Rapid Intra-operative Tumor Classification by ATR-FTIR Spectroscopy of Tissue Smears: A Preliminary Study

D. Malonek[1*], I. Bruchim[2,4], B. Z. Dekel[1], R. Reens Carmel[2], G. M. Groisman[3,4], M. Halak[2,4]
[1]Dept. of Electrical & Computer Engineering, Ruppin Academic Center
Emek Hefer, Israel
dovm@ruppin.ac.il; benziond@ruppin.ac.il;
[2]Gynecologic Oncology Division, Department of Obstetrics and Gynecology, Hillel Yaffe Medical Center
Hadera, Israel
IlanB@hy.health.gov.il; Renatr@hymc.gov.il; mottih@hy.health.gov.il
[3]Department of Pathology, Hillel Yaffe Medical Center
Hadera, Israel
groisman@hymc.gov.il,
[4]Technion Israel Institute of Technology
Haifa, Israel

Extended Abstract

Women with suspected GC undergo surgical procedures during which tissue from suspected areas is excised. Classification of the tissue is performed by histopathology, results of which may be obtained within weeks. Faster histopathology analysis is performed intra-operatively using frozen section (FS) analysis, results of which are available within less than an hour. However, the accuracy of the FS test ranges between 75% and 100% when compared to final histopathology diagnoses.

Fourier transform Infrared (FTIR) spectroscopy, utilized for classification of tissue samples into malignant and benign tumors, has shown comparable results to those of FS histopathology analysis. However, the sample preparation time and the effects of tissue preparation on the measured spectra have been a concern for the utilization of this technique in clinical practice. When fresh tissue samples are used, the water content in the samples masks several spectral ranges and sophisticated digital subtraction algorithms are needed to recover the relevant spectra.

In this study we used attenuated total reflection (ATR) FTIR spectroscopy to examine fresh tissue impression smears as an alternative to the FS technique for rapid classification of tissue samples obtained during surgery. Air drying of these impression smears was rapid (less than 5 minutes) and the obtained spectra were free of the masking water spectral bands.

The study was approved by relevant ethics committees and was conducted in accordance with the Declaration of Helsinki. All patients provided written, informed consent.

In total, 23 biopsies (ovarian and uterine) were extracted from suspected tumor sites during surgical procedures and sent to the histopathology laboratory for both pathological and FTIR analyses. Results of the histopathology analysis classified 15 samples as benign and 8 samples as malignant.

Prior to the histopathologic analysis, ATR-FTIR absorbance spectra of tissue samples from these very same tumors were measured, followed by absorbance measurement of tissue smears; each tissue sample was lightly pressed against the surface of an ATR crystal, leaving on its' surface impression smears. These smears were air dried for ~5 minutes.

Mid-IR absorbance spectra were collected using an ATR-FTIR spectrometer. Machine learning techniques (PCA-LDA and SVM) were utilized to build discrimination models from the absorbance data of the measured samples and smears. Sensitivity and specificity were calculated.

IR absorbance spectra of malignant smears were significantly higher than spectra of benign smears in the 850cm^{-1} to 1450 cm^{-1} range and they were lower in the 3200cm^{-1} to 3600cm^{-1} range ($p<0.001$).

Although the study contained a rather small number of subjects, the PCA-LDA discrimination model was able to differentiate between malignant and benign smears with cross validation accuracy of 95%. The SVM discrimination model showed a training accuracy of 100% and a cross validation accuracy of 91.3%. These preliminary results suggest that ATR-

FTIR spectroscopy of tissue smears may have an important role in the development of next-generation techniques for intra-operative tumor classification.

Acknowledgments

This research was supported in part by Ruppin Academic Center grant to B.Z.D and D.M. and by the ICA grant to I.B, B.Z.D, D.M. and G.M.G.