Polarization Imaging to Identify Disease Features of Gastrinoma

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Background
Gastrinomas are a type of gastroenteropancreatic neuroendocrine tumors found in the pancreas or duodenum causing the production of excessive levels of gastrin. Multiple endocrine neoplasia type 1 (MEN-1) is a rare autosomal-dominant disease, normally associated with a broad range of endocrine tumors, including gastrinoma. Gastrinomas in MEN-1 tend to be small, multiple and preferentially located in the duodenum.5

Motivation
Gastrinomas occur in one to three cases per million people in the USA annually7, with 60 – 90% of these tumors being malignant. Approximately 80% of gastrinomas are sporadic, and 20–30% percent occur in association with MEN-13.

There is a mean delay of 4–7 years in the diagnosis8, and previous studies reported that the sensitivity of conventional imaging techniques for gastrinoma localization was poor, ranging only from 40–70%7. Surgery and previous studies reported that the sensitivity of this procedure. 5- and 10-year survival are > 90% when an isolated tumor is removed surgically, but the success rate is lower with multiple tumors.3

Methods
A custom Nikon Polarrimeter was used to take Mueller Matrix Polarized Light. The system was constructed through modifications of a Nikon ECLIPSE LV100ND POL polarizing microscope. The samples imaged were formalin-fixed paraffin-embedded (FFPE) slides of gastroenteropancreatic neuroendocrine tumors that were obtained through the University of Michigan Endocrine Oncology Repository (IRB #UM000115310). Mueller polarrmetry imaging is used due to its sensitivity to micro and nanoscale structures as predicted by scattering theory. The Nikon Polarrimeter operates in a backscattering configuration and previous studies have demonstrated that light scattering by small scatterers and light absorption are the key factors for observed polarimetric image contrast. Mueller Matrix decomposition were performed to extract polarimetric effects such as diattenuation, retardation, and depolarization. The polarrimeter used captured images at 405, 442, 473, 543, and 632nm. The polarimeters and waveplates were also rotated at 90-, 135-, 180-, and 225-degrees during imaging.

Results
The average values of the depolarization, diattenuation, and retardance, the tumor and the Brunner’s gland display a similar pattern. However, the results indicate a significant difference between the average depolarization of the tumor vs. the Brunner’s gland at 442, 543, and 632nm, and also the average diattenuation of the tumor vs. the Brunner’s gland at 405nm. No significant difference between the retardance of the two tissues was observed. As expected, the depolarization, diattenuation, and retardance values are wavelength dependent, as shown in Table 1. Tiling of the slides shows no significant differences in the depolarization and diattenuation of the tissue but shows that there is significant difference in the retardance measurement.

Our results demonstrate that polarization imaging shows promise for tumor localization. Next steps include expanding sample pool and more advanced statistical analysis.

References
1. Plöckinger, U. "Diagnosis and Treatment of Gastrinomas in Multiple Endocrine Neoplasia Type 1 (MEN-1)." Endocr. 2016; 4:257-264.