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Measuring the hyperspectral and auto-fluorescent signature of esophageal cancer for evaluating diagnostic optical imaging biomarkers using ex vivo clinical specimens.

N. LIMA[1], A. ALAMERI[2], B. BANERJEE[2], H. GAVINI[2], T.W.SAWYER[1]
1. College of Optical Sciences, The University of Arizona, Tucson, AZ, United States.
2. Banner University Medical Center Tucson, Tucson, AZ, United States

INTRODUCTION

Esophageal cancer is increasingly prevalent with a 5-year survival rate below 20% due largely to late detection [1]. **There is a significant need for improved imaging tools that can: 1) detect and localize early, otherwise unseen lesions and 2) be incorporated into endoscopy, for screening and evaluation of early symptoms**. Current endoscopes are limited to the use of white light or narrow-band imaging, which yields contrast via absorption and reflection of light aggregated in three broad spectral imaging filters: red, green, and blue (RGB) [2].

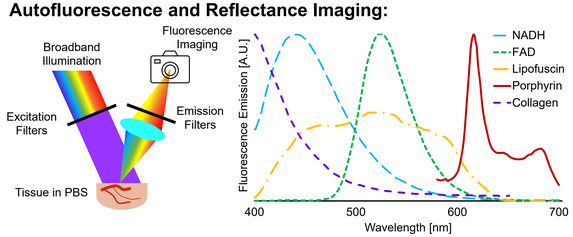
AIM

In recent years, numerous label-free imaging-based techniques have emerged that are potential candidates for optical detection of neoplasia; among them we **evaluate the diagnostic potential of hyperspectral and auto-fluorescent imaging for diagnosis of esophageal cancer.** Hyperspectral imaging can capture a higher density of wavelength encoded light-tissue interactions from chromophores, tissue microstructure, higher nuclei density, or collagen matrix transformations [3]. Autofluorescence imaging can capture information about tissue morphology and metabolic conditions using various excitation and emission bands from single photon fluorescence [4]. Both technologies are well positioned to provide the endoscopist with higher sensitivity tools to diagnose early esophageal cancer when patient prognostic outcomes are highest.

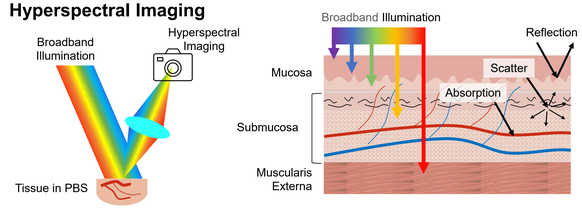
METHOD

We performed ex-vivo imaging on esophageal biopsies suspicious for adenocarcinoma (ADC) and/or Barrett's esophagus and adjacent normal appearing squamous mucosa in the same patient (n=6)

Autofluorescence and Reflectance Imaging:

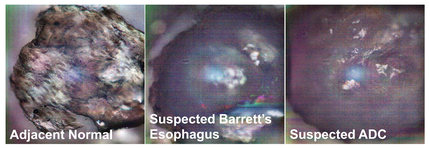


Hyperspectral Imaging

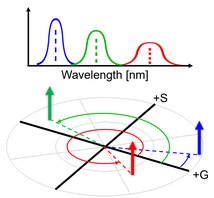


HYPERSPECTRAL RESULTS

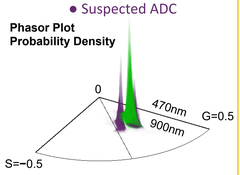
Patient F | Synthetic RGB Images



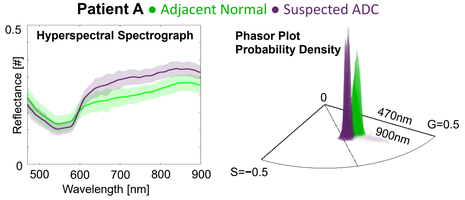
Reading Phasor Plots



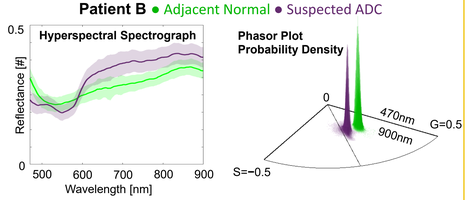
Patients A-F Pooled
● Adjacent Normal
● Suspected ADC



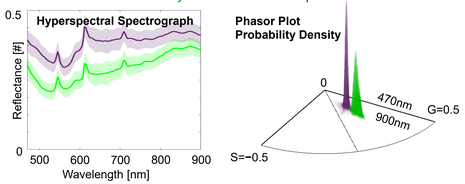
Patient A ● Adjacent Normal ● Suspected ADC



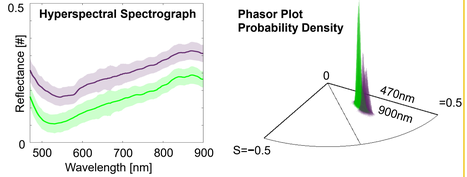
Patient B ● Adjacent Normal ● Suspected ADC



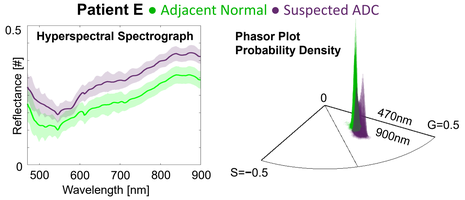
Patient C ● Adjacent Normal ● Suspected ADC



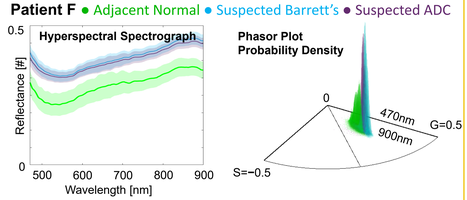
Patient D ● Adjacent Normal ● Suspected ADC



Patient E ● Adjacent Normal ● Suspected ADC

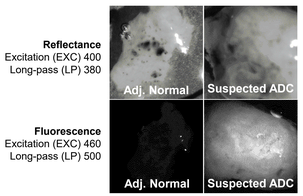


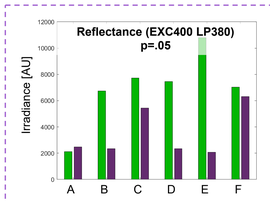
Patient F ● Adjacent Normal ● Suspected Barrett's ● Suspected ADC

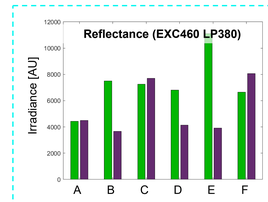


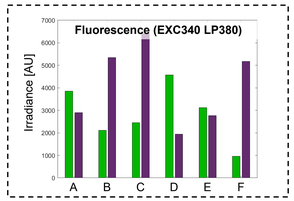
AUTOFLUORESCENCE & REFLECTANCE RESULTS

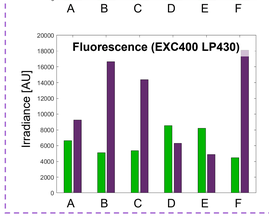
Patient C Image Examples

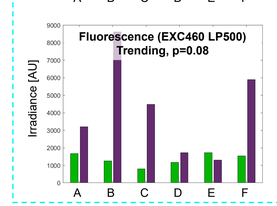


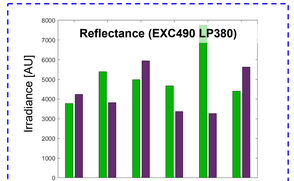


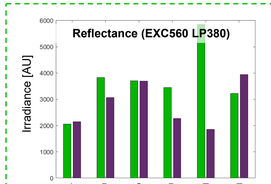


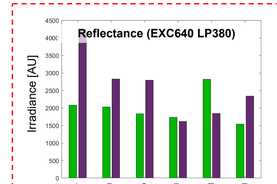


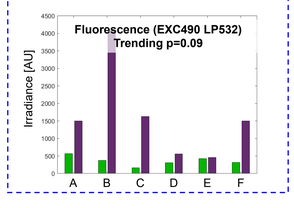


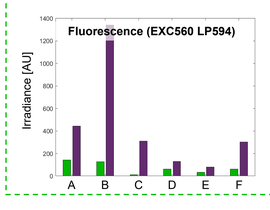


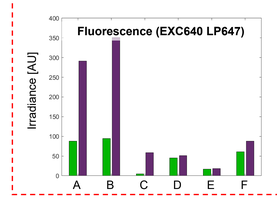












CONCLUSIONS

Significant differences in the hyperspectral signature are observed intra patient samples between adjacent normal tissue and suspected ADC. Trending differences in the hyperspectral signature are observed inter patient samples when clustered between adjacent normal tissue and suspected ADC. The phasor plots provide a clustering visualization of the hyperspectral signature based on central wavelength and bandwidth. All hyperspectral signatures are clustered in the 8th quadrant of the phasor plots and within the 0.25 radius. Significant differences in the reflectance signature based on 400nm illumination are observed interpatient samples when clustered between adjacent normal tissue and suspected ADC (p=0.05). Trending differences in the fluorescence signature based on 460nm excitation \ 500nm emission filter and 490nm excitation \ 532nm emission filter are observed interpatient samples when clustered between adjacent normal tissue and suspected ADC (p=0.08, p=0.09 respectively). **Hyperspectral and auto-fluorescence imaging are both promising imaging modalities for detecting and localizing morphological and metabolic changes associated with esophageal cancer**. Both technologies can be used to guide new endoscopic imaging architectures for point-of-care diagnosis and screening without the need for any exogenous contrast agents.

REFERENCES

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[4] A. C. Croce and G. Bottiroli, "Autofluorescence Spectroscopy and Imaging: A Tool for Biomedical Research and Diagnosis," Eur J Histochem, vol. 58, no. 4, p. 2461, Dec. 2014, doi: 10.4081/ejh.2014.2461.

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CONTACT INFORMATION

Natzem Lima | limanatzem@arizona.edu

Travis W. Sawyer | tsawyer9226@arizona.edu