Rapid Spectroscopic Assessment of Prostate Cancer Biopsy Adequacy and Genetic Quantification

Durack JC[1], Patel D[1], Cai L[1], Alviar D[2], Dylov D[3], Yazdanfar S[3], Gopalan A[2], Buonocore D[2], Solomon SB[1], Scher HI[1]

1. Memorial Sloan Kettering Cancer Center, New York, NY
2. CUNY City College of New York, New York, NY
3. GE Global Research, Niskayuna, NY

Background

Immediate feedback regarding quality and sufficiency of prostate biopsy specimens could improve diagnostic yield and prognostic accuracy. We have developed a specialized optical spectroscopy instrument to rapidly image core needle biopsy samples prior to histopathologic or molecular characterization. In this study, we analyzed resected prostate gland ex vivo biopsies 1) to determine whether spectral classification algorithms can effectively differentiate normal prostate or benign prostatic hypertrophy from prostate cancer, and 2) to determine whether biopsy sample DNA quantity can be predicted at the point of care using spectroscopy imaging.

Methods

We performed an Institutional Review Board approved prospective study of prostatectomy specimens biopsied immediately after resection from 8/2014-9/2016. Up to eight 18G side-notch core needle samples were obtained from each gland, and each core biopsy specimen was scanned using a transmission optical spectroscopy device in less than 1 minute. A library of light spectroscopy profiles was compiled based on spectral data acquired at approximately 0.75mm intervals along 2cm core biopsy samples. Resulting spectra were normalized and distributed against geometrical means and outliers were rejected. The spectral data was decomposed into principal components and a random forest classification algorithm was used to differentiate between malignant versus non-malignant tissue. Following biopsy specimen imaging, either histopathological (H&E-stain) slide review or DNA quantification was performed.

Results

Thirty-nine prostate glands were biopsied during the 25-month study period, providing 221 biopsy samples and over 4600 spectra. Histopathologically normal prostate tissue and BPH were nearly indistinguishable spectroscopically. Histopathologically confirmed prostate cancer spectra were clearly distinct from normal and BPH spectra, enabling binomial classification (tumor vs. benign/normal). DNA quantification and optical spectroscopy correlation studies are ongoing.

Conclusions

We have demonstrated that tissue-preserving optical light spectroscopy analysis of prostate core needle biopsies is feasible, fast, accurate and capable of differentiating multiple tissue subtypes at the time of biopsy. Future studies will focus on time-of-biopsy genetic quantification for samples intended for DNA sequencing and mutation analysis. This instrument represents a promising technology to improve the quality of prostate cancer biopsies, with direct implications for patient safety and personalized treatment planning.