

Augmented intraoperative surgical vision for the assessment of gastrointestinal cancer resection margins

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Background Information

Neoadjuvant treatment has been shown to increase survival for several gastrointestinal cancers. However, tumour regression can make it difficult to distinguish between tumour and scar tissue. Either excessive tissue is resected, increasing morbidity, or circumferential resection margin (CRM) is positive, reducing survival. Negative CRMs are checked via frozen section: a slow, subjective, and expensive approach. A technology for intraoperative CRM assessment is needed.

Diffuse reflectance spectroscopy (DRS) is an optical technique that allows tissue characterisation based on the unique optical properties of each tissue. This project aims to determine if DRS can distinguish between tumour and normal tissue.

Methods

Fresh *ex vivo* samples were scanned with a hand-held DRS probe during the gastrointestinal cancer lists, over an 8-week period. The DRS probe illuminated tissue areas with broadband light (low-power, non-destructive), while the corresponding DRS spectra were collected using a USB spectrometer. Data acquisition and real-time processing was integrated using a MATLAB (MathWorks, USA) interface. Differences in DRS signal intensities across the visible spectra were tested for significance via Wilcoxon rank-sum test.

Results

A total of 30,600 spectra were collected from 179 *ex vivo* samples. Manual macroscopic image-based matching or synchronised histopathology slide preparation was used to match each DRS sample with the corresponding histopathology report. In this pilot study, matched normal and cancerous tissue had statistically significant differences in DRS intensities across the spectrum ($p < 0.01$), and normal tissue post chemoradiation had significantly different spectra compared to treatment naive tissue ($p < 0.01$).

Conclusion

DRS may be able to distinguish between cancer and normal tissue intraoperatively, including after neoadjuvant chemotherapy. Challenges remain in establishing a reliable histology co-registration methodology and in scanning heterogeneous tissue structures.

Key words: *Diffuse reflectance spectroscopy, hyperspectral imaging, optical biopsy, circumferential margin assessment, diffuse reflectance spectroscopy.*