

Multimodal vibrational spectroscopy for colorectal tumour classification: preliminary findings from a feasibility pilot

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RESEARCH WEEK
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Background

Accurate identification of residual rectal cancer after neoadjuvant therapy is critical for Watch-and-Wait selection. Current assessment may not reliably distinguish tumour from treatment-related fibrosis. Raman spectroscopy (RS) and near-infrared spectroscopy (NIRS) provide complementary, non-destructive biochemical tissue assessment with potential for endoscopic integration.

Aim

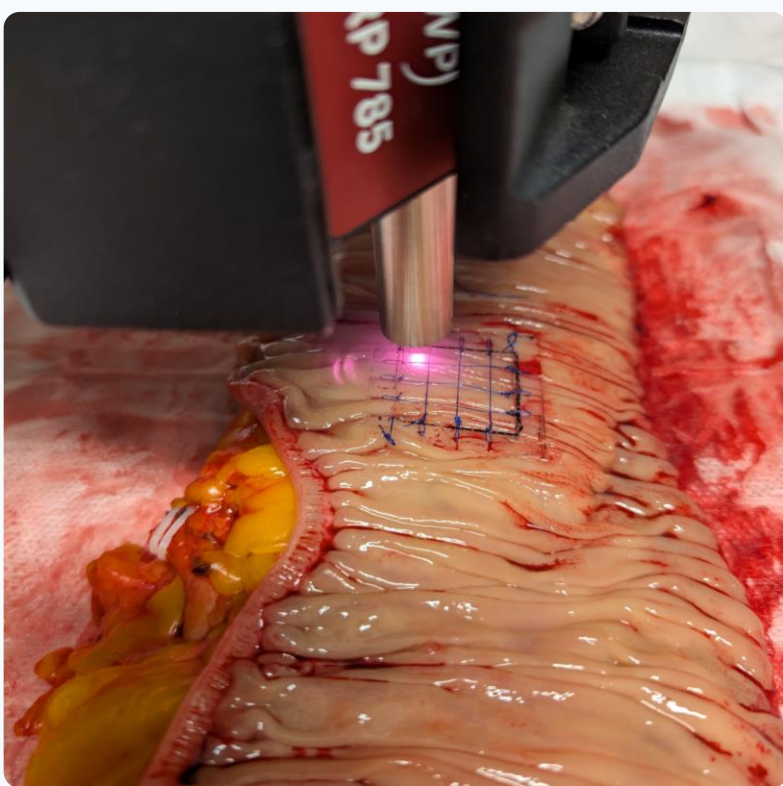
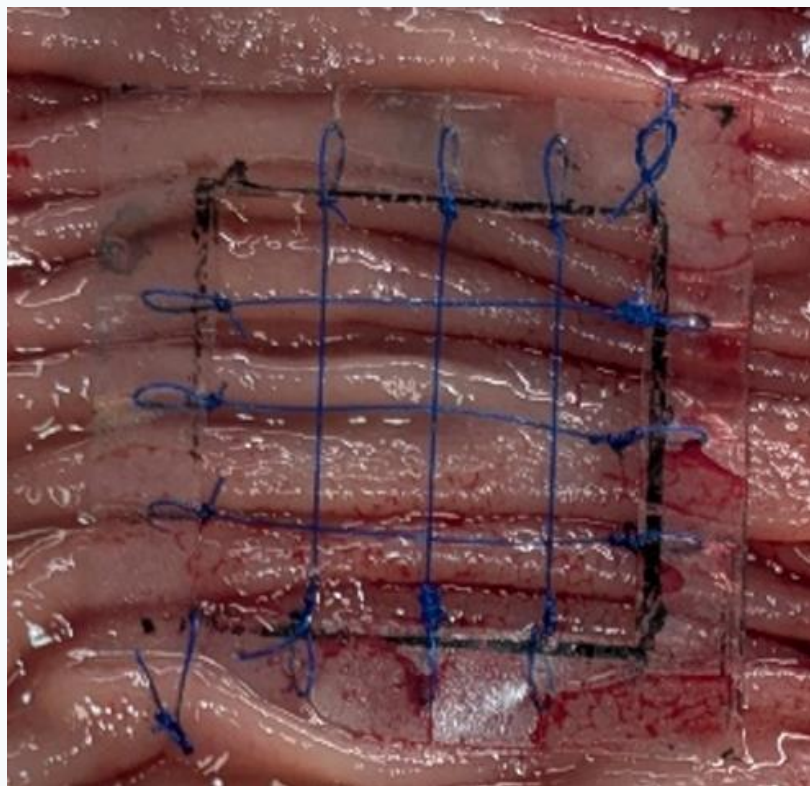
To assess feasibility of spatially matched RS and NIRS acquisition and preliminary cancer versus non-cancer discrimination in fresh colorectal specimens using histology as the reference standard.

Methods

Prospective pilot study of elective colorectal cancer resections. Tumour and macroscopically normal control regions were mapped on fresh whole specimens using 2 × 2 cm grids. Spectra were assigned histology-derived labels. Modality-specific preprocessing and partial least-squares discriminant analysis used patient-grouped cross-validation; exploratory multimodal analysis used early and weighted late fusion.

Fresh-specimen workflow

1. Fresh specimen	elective colorectal resection
2. Pathology mapping	tumour and control areas
3. Grid placement	2 × 2 cm regions
4. Spectral acquisition	RS and NIRS
5. Histology correlation	grid-square labels
6. PLS-DA	patient-grouped validation



Spatially mapped 4 × 4 grid during Raman acquisition

Results



Dataset

Modality	Spectra	Patients
Raman	464	5
NIRS	539	6
Multimodal	368 fused	4

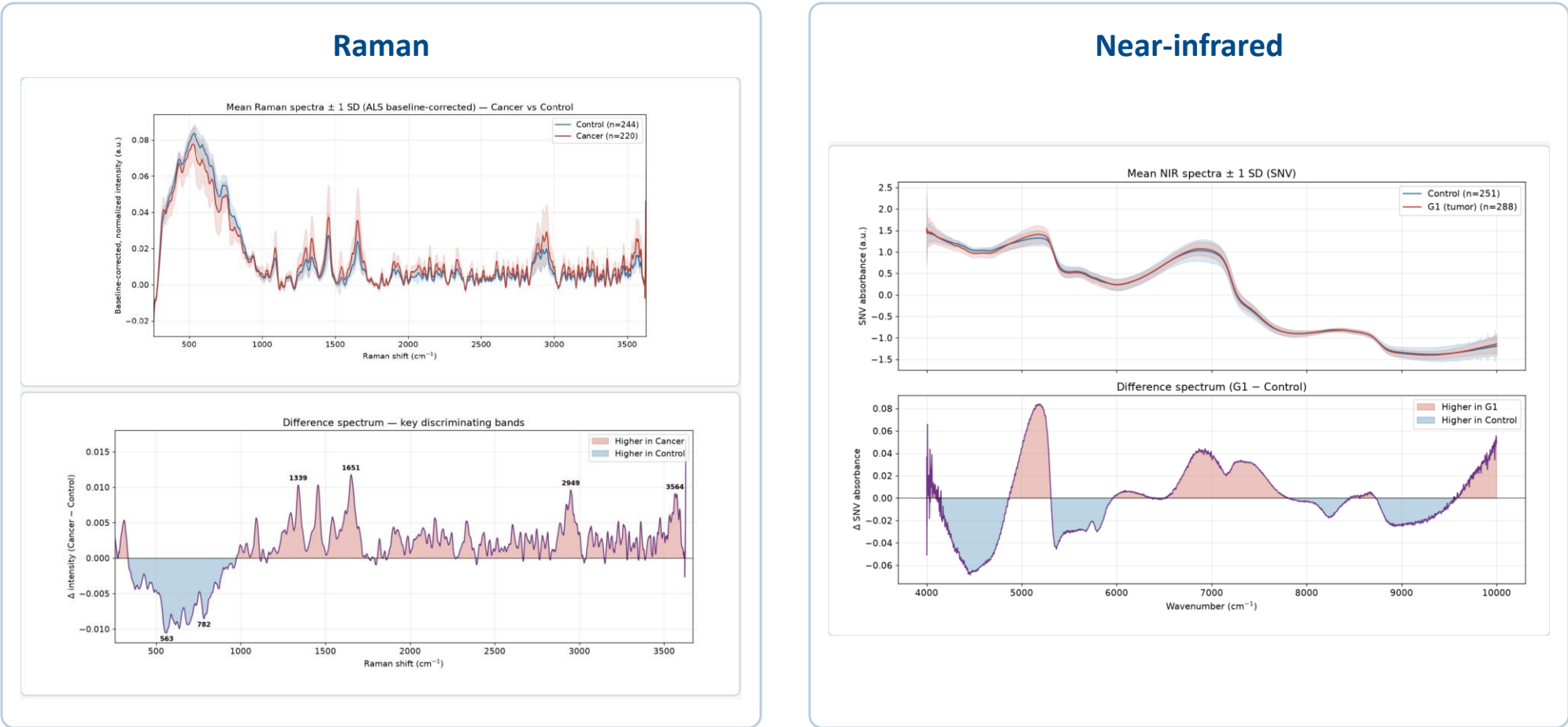
Single-modality performance

Model	AUC	Accuracy	Sensitivity	Specificity
Raman	0.83	79.0%	66.0%	91.0%
NIR	0.97	91.5%	93.1%	89.6%

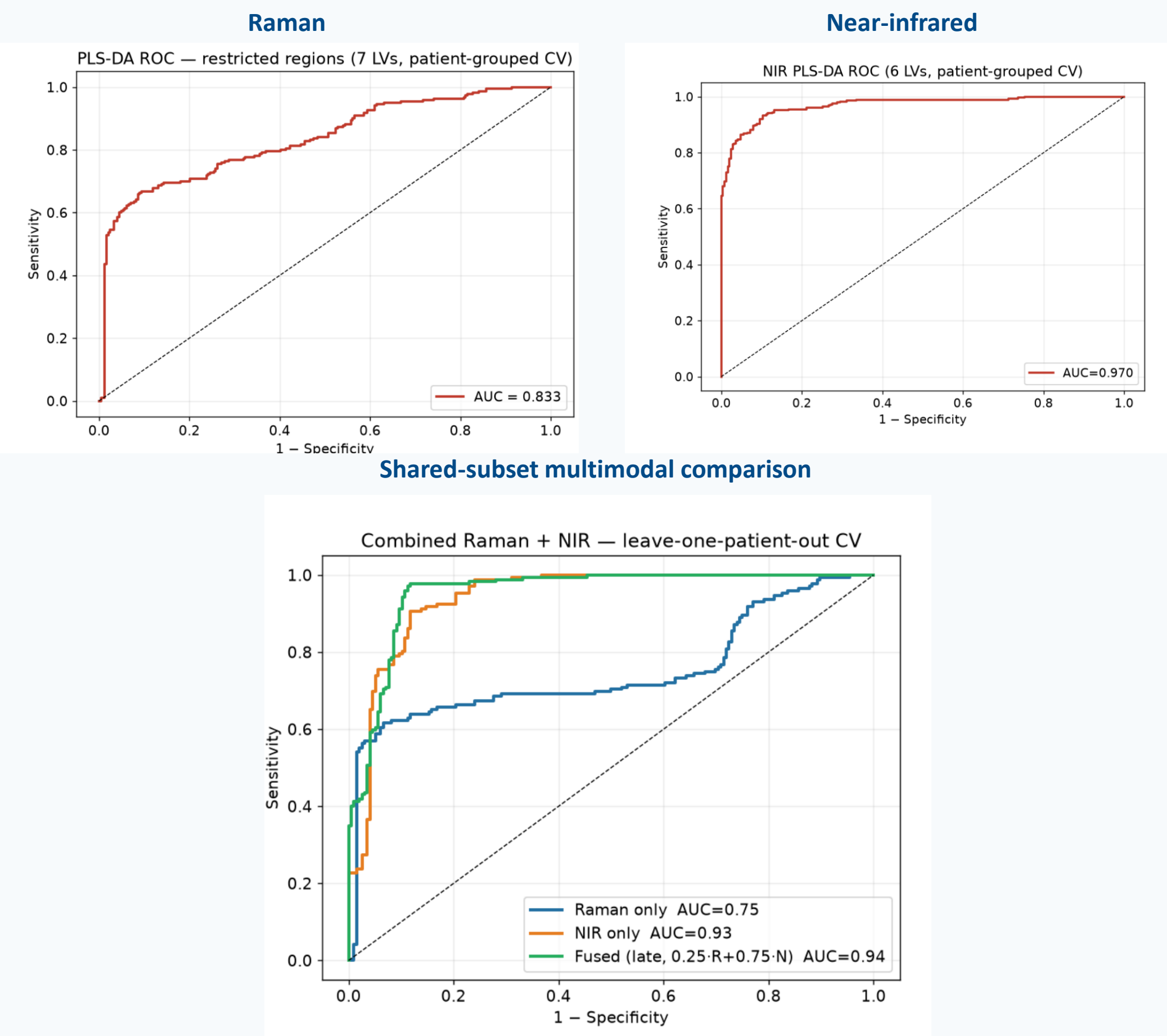
Shared patient subset

Model	AUC
Raman alone	0.75
NIR alone	0.93
Early fusion	0.90
Weighted late fusion	0.94

Spectral findings



Discrimination performance



Key findings

- RS and NIRS produced analysable spectra within the fresh-specimen workflow.
- NIRS achieved the strongest standalone discrimination (AUC 0.97).
- Weighted late fusion achieved AUC 0.94 in the four-patient shared subset.

Limitations

Only 4–6 independent patients; repeated spectra within patients; no external validation; general colorectal resections rather than exclusively post-neoadjuvant rectal cancer.

Conclusion

Multimodal spectroscopy was feasible in fresh colorectal resection specimens and showed promising preliminary cancer versus non-cancer discrimination. Larger prospective studies using directly paired RS and NIRS measurements spatially matched to histopathology in post-neoadjuvant rectal cancer are required before clinical translation.