



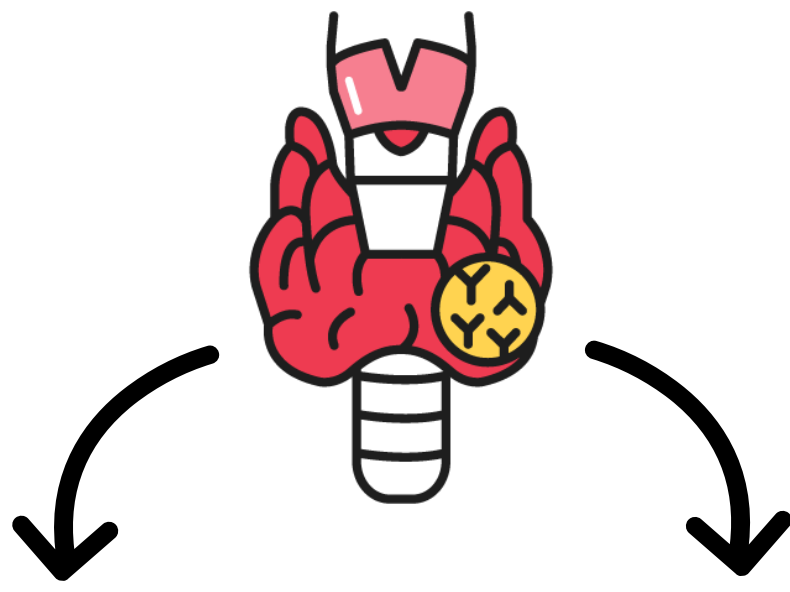
Improving the Diagnosis of Thyroid Cancer Using Diffuse Reflectance Spectroscopy

N. R. Chander, R. Ranjitkar, I. Gkouzionis, M. Moonim, A. Darzi, C. J. Peters, D. S. Elson, A. N. Di Marco

How do we currently diagnose thyroid cancer?

What is a thyroid nodule?

A thyroid nodule is a growth of cells within the thyroid gland which can form a lump
Thyroid nodules are estimated to be **present in 19-35%** of patients on ultrasound scan¹



Most nodules are benign, requiring no treatment

4-7% of nodules are cancers²

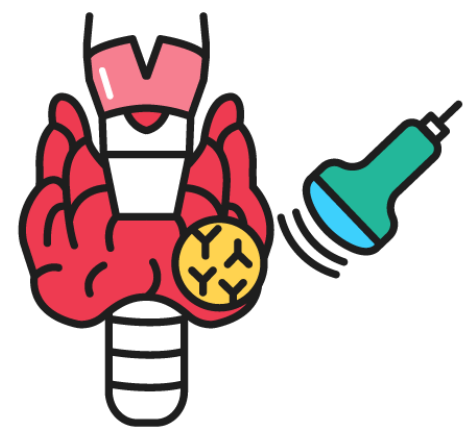
This equates to around **4,000** new cases of thyroid cancer diagnosed in the UK each year³

The incidence of thyroid cancer has increased by 65% over the last decade, yet survival rates remain unchanged³

It is important we can identify which nodules are cancers so they can be appropriately treated

How do we currently identify which nodules are cancerous?

The nodule is assessed with an **ultrasound scan** to look for features suggestive of cancer

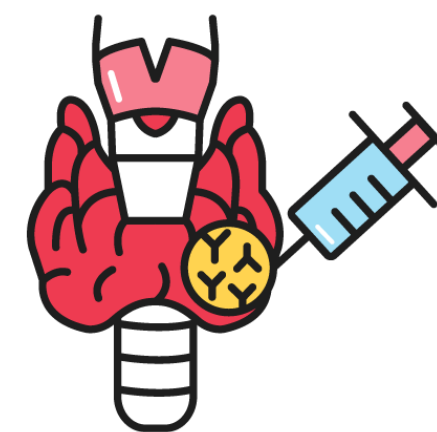


Despite these tests, **39-52% of nodules remain indeterminate⁴** – in these cases it still cannot be confirmed if the nodule is cancer or not

Patients with **indeterminate nodules require surgery** to remove the thyroid lobe

This allows formal assessment of the nodule under a microscope to confirm if it is cancerous or benign

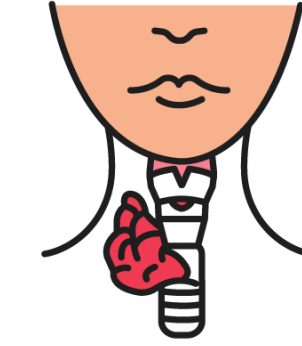
If there are any concerning features, a **biopsy** of the nodule is taken with a **fine needle**



What are the limitations of this?

For patients having diagnostic surgery for an indeterminate thyroid nodule, **the chance of the nodule being cancerous is 17-68%⁴**

If the nodule is confirmed to be benign...



...the patient has undergone unnecessary surgery (with the risk of complications, and emotional/financial implications of surgery)

If the nodule is confirmed to be cancer...



...the patient may require more surgery to remove the other half of their thyroid (therefore surgery in two stages which could have been performed in one)

The impact on the NHS must also be considered



Our proposed technique

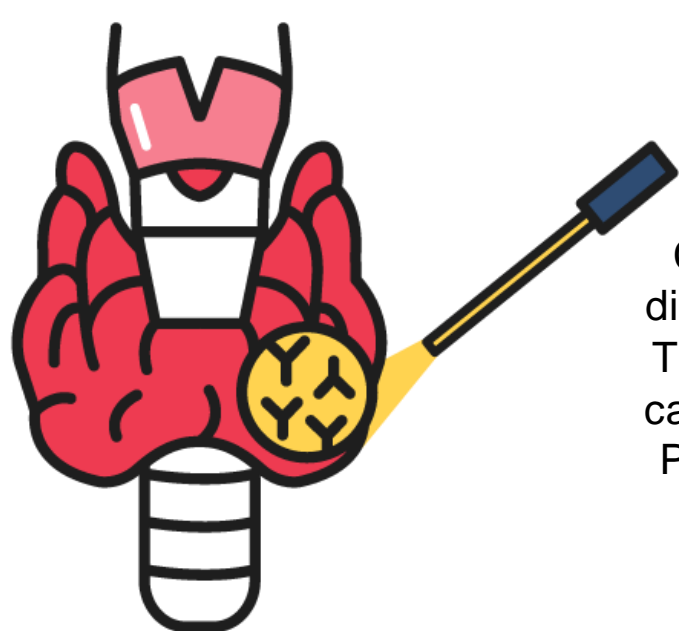
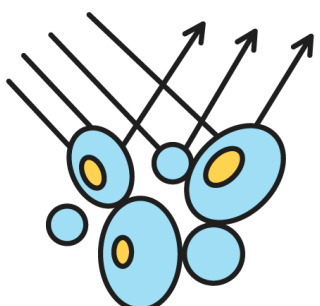
Diffuse reflectance spectroscopy

What is DRS?

Diffuse reflectance spectroscopy is an optical technique where a probe is placed into direct contact with tissues

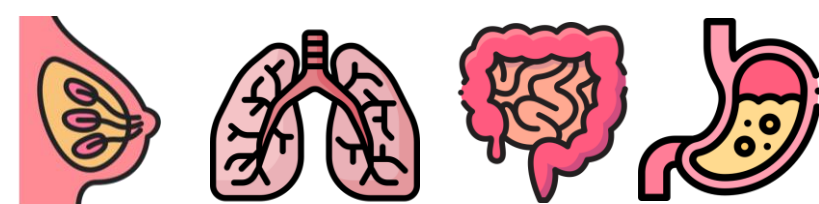
How does it work?

The probe emits light and simultaneously measures the wavelength and intensity of light reflected back (spectral data). Due to the different ways various tissues interact with light, the characteristics of this reflected light can provide valuable information⁵



How can it help diagnose cancer?

Cancerous tissues are structured differently to non-cancerous tissues. The way they reflect light differently can be picked up by the DRS probe. Previous studies have shown DRS can diagnose cancer in the lung, breast, bowel and stomach⁶⁻⁹



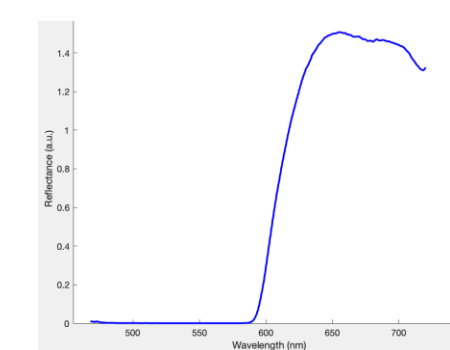
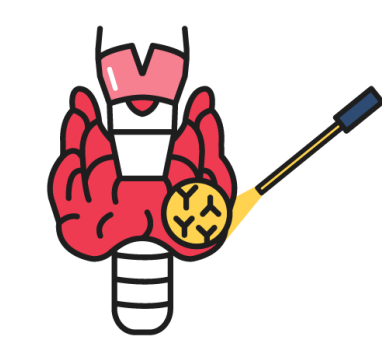
Our study



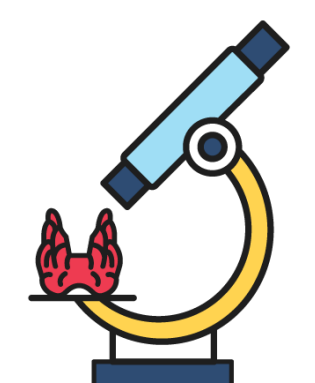
Our hypothesis:

DRS can differentiate cancerous from benign thyroid nodules, even in indeterminate nodules (where ultrasound and biopsy have been unable to do so)

DRS was used during surgery on adult patients
Spectral data was collected from freshly resected thyroid nodules



The true diagnosis of whether the nodule was cancerous or benign was confirmed on histology (microscopic study)



Spectral data was compared from cancerous and benign nodules
A supervised machine learning classifier was used to process the data and look for key differences

Our findings

Study demographics

54 patients with 56 thyroid nodules

According to ultrasound and biopsy...

13 benign 21 cancer

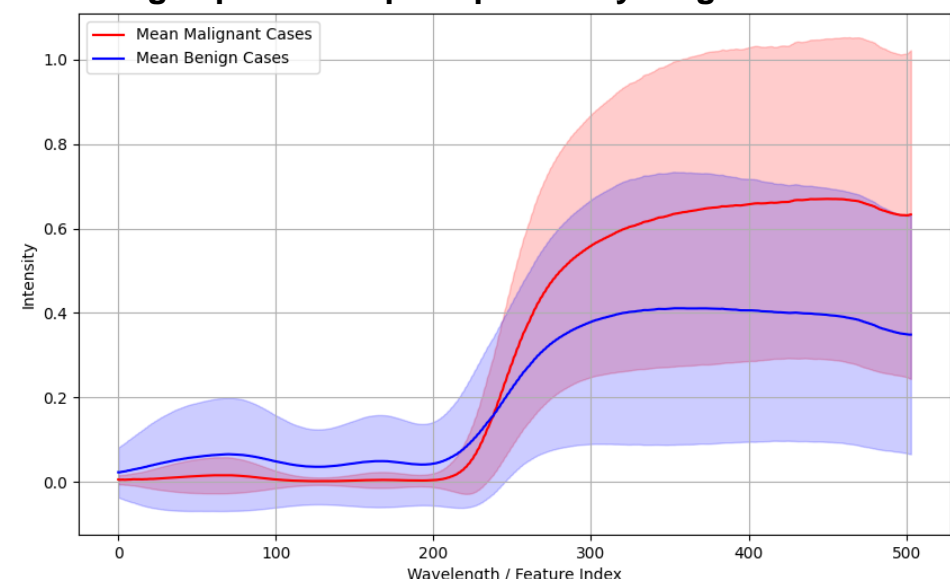
22 indeterminate

Histology results subsequently confirmed...

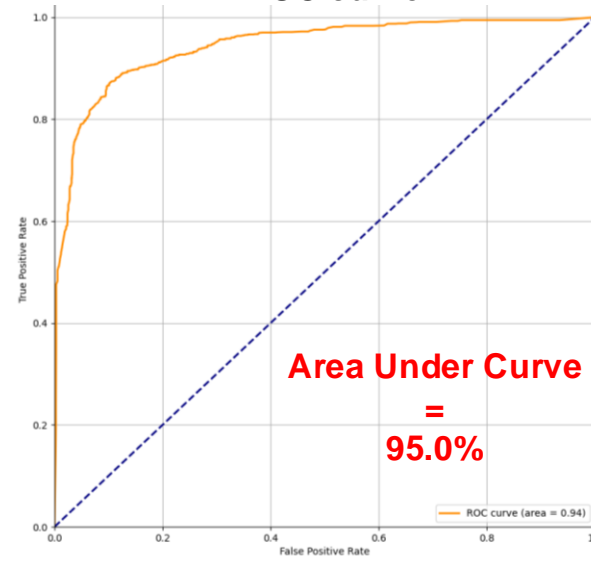
15 benign 7 cancer

Performance of the DRS system

Average spectra for pre-operatively diagnosed nodules

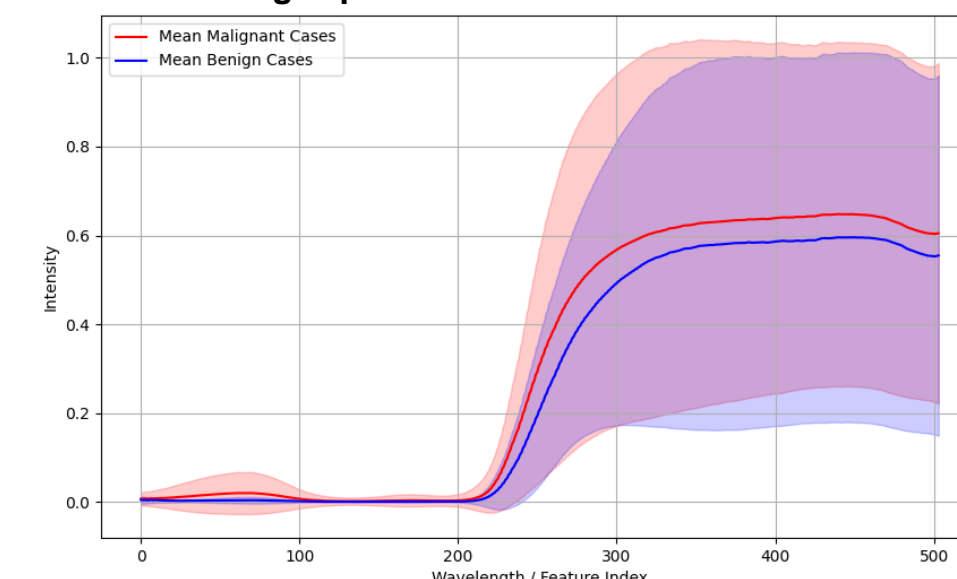


ROC curve

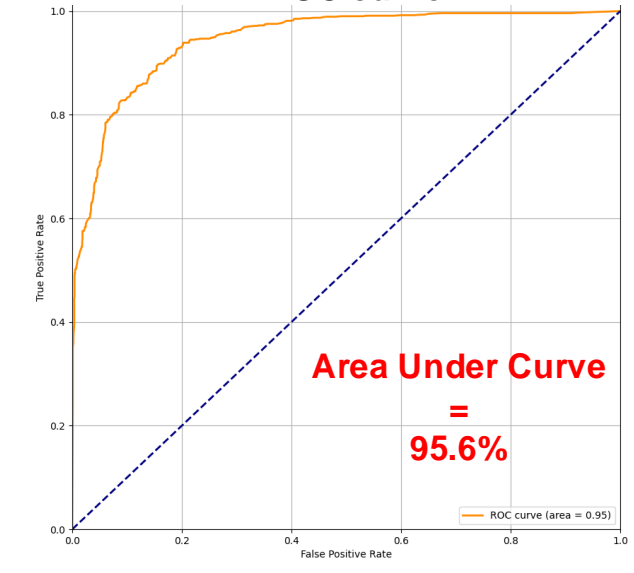


In thyroid nodules with a pre-operative diagnosis, DRS could detect malignancy with a **diagnostic accuracy of 88.3%** (sensitivity 86.9%, specificity 89.5%)

Average spectra for indeterminate nodules



ROC curve



In indeterminate thyroid nodules, the **diagnostic accuracy** of DRS was preserved at **88.4%** (sensitivity 79.6%, specificity 92.6%)

How can this help patients?

DRS can diagnose cancer in thyroid nodules with an accuracy of over 88% - **this accuracy exceeds the current diagnostic method of ultrasound and biopsy**

DRS may be therefore be used to:

1. Reduce the rate of unnecessary diagnostic surgery
2. Allow planning for more accurate surgery in a single rather than two-stage procedure



Our study shows DRS has the potential to revolutionise the diagnosis and management of thyroid cancer and transform patient care

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