THE UNIVERSITY of ADELAIDE

Hybrid Imaging Catheter

The world's smallest 3D printed multimodal (OCT/autofluorescence) imaging lens for imaging and characterising plaque deposits in coronary arteries.

Background

Each year, more than 20 million patients with coronary artery disease have acute coronary syndrome, most of which are caused by high-risk atherosclerotic plaques.

Intravascular imaging technologies are used to improve coronary intervention guidance and plaque characterisation. Current solutions include intravascular ultrasound (IVUS) or optical coherence tomography (OCT) which provide cardiologists with high-resolution images of a patient's blood vessels, and guide treatment.

The most critical task in intravascular imaging is identifying high-risk atherosclerotic plaques. These are the lesions in the blood vessel that are most likely to lead to a heart attack and require treatment. Evidence from histology-based studies indicates current techniques may fail to identify high-risk plaques which leaves the patient at risk, or erroneously misclassifies stable plaques resulting in over-treatment.

Technology overview

There is an unmet need to reliably detect high-risk plaques before they are life-threatening.

Our novel lens design resolves the inherent conflicting optical properties needed by each imaging modality in a single fibre multimodality system, while ensuring that the system is highly miniaturised (0.52 mm: half the size of current imaging catheter).

Two-photon 3D printing is used to create a complex micro-optical lens for fluorescence and OCT that achieves fluorescence with a sensitivity boost 14 times higher (Figure 1) than existing technologies; and high-resolution OCT over 1-mm range. Our solution enables cardiologists to offer a personalised cardiac treatment approach with the ability to characterise the plaque present, and eliminate erroneous misclassification of plaques which currently results in over-treatment (and cardiac episodes in 30% of cases.

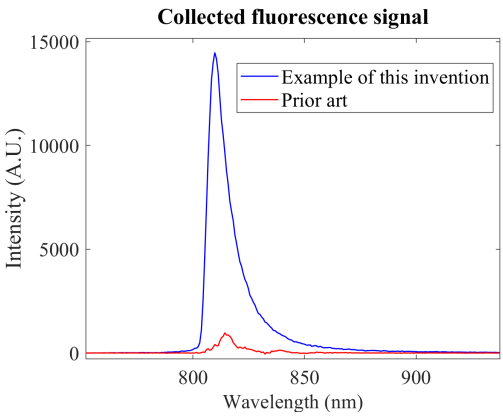

Figure 1.

Applications

The major application is for detection of high-risk plaques (cardiovascular diseases). However other uses include imaging for lung cancer, gene therapy, gastrointestinal tract and the bile duct for cancers such as cholangiocarcinoma.

Development status

A prototype was developed for the technology and tested on lab rodents in vivo (see Figure 2). Large animal trials (pig model) are underway.

IP Status

- PCT Published WO2022016230A1.
- Clear International Examination Report on novelty and inventiveness achieved 01/02/2022 - PCT/AU2021/050797,
- Entered National Phase for the designation of Australia; China, Japan, the United States; Europe, India and Hong Kong.

Publications

1. Light: Science and Applications
2. Small Nano Micro Article published by Wiley-VCH GmbH

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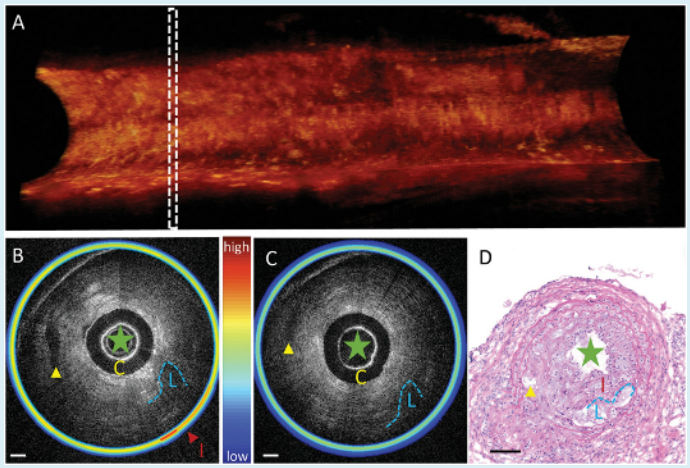

Figure 2.

A. 3D OCT in-vivo imaging of diseased mouse artery using our lens.

B. OCT (grey) and fluorescence (colour) cross-sections of the mouse artery - red triangle marks a localised high fluorescence signal (red), indicating inflammation in those regions of the plaque.

C. Cross-sectional OCT and fluorescence images acquired using a conventional GRIN fibre lens probe from the same location as (B) showing less fluorescence sensitivity.

D. Corresponding histology image. Scale bar: 100 µm.

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