MEDICAL IMAGING

Acoustic waves that make maps of tumours

Simon Hadlington on a new technique for collecting ultrasound signals that will allow better, more detailed analysis of human tissues

A new method of making images of human tissues is emerging based on the phenomenon of a body absorbing light energy and emitting an acoustic wave. It could lead to better treatments for diseases such as cancer.

The technique, called photoacoustic imaging, is good at producing high-quality, three-dimensional maps of blood vessels. The tiny blood vessels that feed tumours with oxygen and nutrients play a key role in determining how a tumour might respond to different therapies.

A company called Opto-Sonics, based in Indianapolis, has developed a prototype photoacoustic breast scanning device, while another team of US scientists, led by Professor Lihong Wang in the optical imaging laboratory at Texas A&M University, has used the technique to observe patterns of blood flow around the brain of a rat – a measure of the brain's activity.

Researchers at University College London are developing detectors for photoacoustic imaging that will enable images to be produced in finer detail than now possible.

Paul Beard is leading the research at UCL: "Photoacoustic imaging relies on exposing the body's tissues to short pulses of low-energy laser light in the near-infrared region of the spectrum," he says. "The light is absorbed by the various tissues and structures and this causes them to rise in temperature by a tiny amount, a few fractions of a degree."

This induces "thermo-elastic expansion" in the tissues – they expand by a minuscule amount. The expansion is sufficient to generate a pulse of ultrasound, which travels back to the surface of the body. The signal can then be detected and analysed.

The phenomenon of a body absorbing light energy and emitting an acoustic wave was first noted by Alexander Graham Bell at the end of the 19th century.

"Because different structures absorb the light to different degrees, the magnitude of the returning ultrasound wave can give us information about the tissues," says Dr Beard. "The length of time it takes for the ultrasound signal to reach the surface tells us about how far the particular anatomical structure is beneath the surface. Positioning detectors on the body allows a way to produce a three-dimensional image of the tissues."

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The UK researchers are working on a new type of sensor for collecting the ultrasound signals. Conventional ultrasound detectors are made from piezoelectric materials. These produce an electrical signal when stimulated mechanically, in this case by a sound wave. But their resolution is limited.

Dr Beard's research team has developed a sensor in which a sheet of fine polymer film is sandwiched between two transparent plates. When the ultrasound strikes the polymer film, the thickness of the film changes at that point. A separate source of light is continuously reflected from the surface of the film, and when the film is altered by an ultrasound wave, the pattern of the reflected light is also altered. The system can provide high resolution, creating more detailed images of tissues.

Photoacoustic imaging is especially suited to detecting blood vessels. The pigment haemoglobin absorbs near-infrared light efficiently, producing a strong, unambiguous photoacoustic signal. In this way, maps of blood vessels can be imaged. The signal changes, depending on how much oxygen the blood is carrying. This is important for assessing the status of a tumour.

"It is extremely useful to know how much oxygen a tumour is receiving from its blood supply, as this can help us predict how the tumour will respond to treatment," says Dr Gill Tozer, head of the tumour microcirculation group at the Gray Cancer Institute in London. "Tumours that are poorly oxygenated can become resistant to treatment."

The UCL scientists have imaged "phantom" blood vessels a few tenths of a millimetre in diameter in synthetic model systems that mimic real organs. The next stage would be to test the technology in humans.

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