Light and sound -- the way forward for better medical imaging

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Detection and treatment of tumours, diseased blood vessels and other soft-tissue conditions could be significantly improved, thanks to an innovative imaging system being developed that uses both light and sound.

The system uses extremely short pulses of low-energy laser light to stimulate the emission of ultrasonic acoustic waves from the tissue area being examined. These waves are then converted into high-resolution 3D images of tissue structure.

This method can be used to reveal disease in types of tissue that are more difficult to image using techniques based on x-rays or conventional ultrasound. For example, the new system is better at imaging small blood vessels, which may not be picked up at all using ultrasound. This is important in the detection of tumours, which are characterised by an increased density of blood vessels growing into the tissue.

The technique, which is completely safe, will help doctors diagnose, monitor and treat a wide range of soft-tissue conditions more effectively.

The first of its kind in the world, the prototype system has been developed by medical physics and bioengineering experts at University College London, with funding from the Engineering and Physical Sciences Research Council (EPSRC). It is soon to undergo trials in clinical applications, with routine deployment in the healthcare sector envisaged within around 5 years.

The emission of an acoustic wave when matter absorbs light is known as the photoacoustic effect. Harnessing this basic principle, the new system makes use of the variations in the sound waves that are produced by different types of soft human tissue to identify and map features that other imaging methods cannot distinguish so well.

By appropriate selection of the wavelength of the laser pulses, the light can be controlled to penetrate up to depths of several centimetres. The technique therefore has important potential for the better imaging of conditions that go deep into human tissue, such as breast tumours, and for contributing to the diagnosis and treatment of vascular disease.

The prototype instrument, however, has been specifically designed to image very small blood vessels (with diameters measured in tens or hundreds of microns) that are relatively close to the surface. Information generated about the distribution and density of these microvessels can in turn provide valuable data about skin tumours, vascular lesions, burns, other soft tissue damage, and even how well an area of tissue has responded to plastic surgery following an operation.

The development process has included theoretical and experimental investigations of photoacoustic interactions with soft tissue, development of appropriate computer image-reconstruction algorithms, and construction of a prototype imaging instrument incorporating the new technique.

“This new system offers the prospect of safe, non-invasive medical imaging of unprecedented quality,” says Dr Paul Beard who leads UCL’s Photoacoustic Imaging Group. “It also has the potential to be an extremely versatile, relatively inexpensive and even portable imaging option.”

Source: Engineering and Physical Sciences Research Council