Measuring ultrasound for better treatment of muscle injuries

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A new tool developed at the National Physical Laboratory (NPL), the UK's National Measurement Institute, could help improve the quality of ultrasound treatment for soft tissue injuries such as muscle strains and ligament damage.

Ultrasound - high-frequency sound waves – is used in physiotherapy to accelerate healing of tissue injuries. Ideally, the sound waves should be applied uniformly to the treatment site, but it is well-known that this does not happen in practice. This can affect quality of treatment and even cause damage.

NPL has developed a way to quickly map the intensity and distribution of ultrasound, allowing treatment heads to be used to administer the treatment more effectively. It will alert physiotherapists to sharp "hot-spots", allowing them to move the head to smooth the intensity or reject it where it could cause more harm than good. It also has potential for manufacturers, who could quickly test the effect that changes in design have on the intensity distribution.

During treatment, piezoelectric-based treatment heads convert electrical energy to mechanical energy, creating the vibrations needed to produce the ultrasound waves. These are transmitted into the target tissue with the aid of a thin layer of coupling gel.

The treatment heads actually vibrate in a complex pattern, in part due to the fact that they are highly resonant devices. This leads to variations in acoustic pressure and acoustic intensity over the area being treated, resulting in 'hot-spots', which can cause excessive heating and even damage to the tissue. Without carrying out the complex and time-consuming process of mapping the acoustic field, it is very difficult to tell exactly where the acoustic energy is going.

NPL scientists have come up with a solution to this problem by developing a simple tool to help visualise the distribution and intensity of the acoustic energy. The method works by using crystals that are thermochromic, meaning that they lose their colour when heated up above a specific trigger temperature. Importantly, the effect is reversible; the crystals regain their original colour on cooling.

The tool consists of two-layers. The bottom layer is made up of the thermochromic crystals embedded in a polyurethane rubber matrix which absorbs sound. The top layer is colourless and is used to trap the heat within the tile. The tile heat produced by the acoustic energy is quickly and evenly trapped, and the crystals turn white as they reach the trigger temperature. This then produces a pattern on the tile which represents the temperature distribution generated by the treatment head, which in turn relates to the spatial distribution of the acoustic intensity. The pattern can be clearly visible within seconds of exposure to the ultrasound.

Bajram Zeqiri, an NPL Science Fellow who led the project, describes how you would test an ultrasound treatment head with the tiles:

"In clinical practice the new 'imager' tiles would be used in much the same way you would treat a patient: by applying coupling gel to the treatment head, coupling it to the tile, switching on for typically 10 seconds, and then removing and observing the resulting image."

This means that the tiles can be used to quickly check for treatment head damage, asymmetric beam-patterns or 'hot-spots', and more simply to confirm whether the devices are actually working at all. The ability to gain relatively complex information from a simple and cost-effective device, in such a short period of time, should help improve the quality of physiotherapy ultrasound treatments.

More information:

www.npl.co.uk/science-technology/acoustics/

Provided by National Physical Laboratory