Shaken and Stirred: Therapeutic Applications of Acoustic Nanobubbles

Coussios Constantin[1].
[1]Biomedical Engineering and Director of the Institute of Biomedical Engineering, University of Oxford.

The linear and non-linear response of microbubbles to acoustic excitation underpins a wide range of therapeutic applications, including drug delivery to tumours or the brain, and non-invasive tissue fractionation for surgical applications. Traditionally, acoustic cavitation in the body has been facilitated by the administration of microbubbles, but several emerging applications make it necessary to seed cavitation from particles much smaller than a micron, in order to match the lengthscales imposed by biological barriers. A new generation of nanobubble-stabilizing solid particles makes it possible to cause cavitation at acoustic pressures that are readily achievable at depth within the body, and sustain it over timescales that setup acoustic microstreaming to enable enhance transport of drugs and nutrients. The acoustic emissions generated by nonlinearly oscillating bubbles can be further exploited to monitor the treatments in real time, using a conventional ultrasound array in conjunction with a technique known as Passive Acoustic Mapping (PAM). Combined, these techniques for making, mapping and using acoustic nanobubbles can enable improved delivery of modern immuno-oncology agents to cells and tumours, needle-free transdermal drug delivery and vaccination, and new spinal therapies to treat the spinal cord or repair the intervertebral disc.