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Systems, Methods, and Devices for Providing Mesoscopic Mechanical Disturbances to Soft Tissues

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Magnetic resonance elastography (MRE) is a useful tool for characterizing and mapping the nonlinear viscoelastic properties of the human brain. It has shown that the stiffness of brain regions change with age and disease states. As such MRE has great utility in clinical diagnostics since many disease states are associated with changes in cellular elasticity. The recent increase in MRE usage indicates a growing interest in studying the mechanical properties of the brain and how they relate to function or dysfunction. However, there is a need to improve the spatial resolution of current elastographic imaging methods.

State of the art methods for introducing mechanical waves to the brain to support elastographic imaging do not implement mechanical waves adequately matched to functional brain nuclei or circuits. The current types of coarse mechanical approaches have poor spatial resolutions for targeting discrete functional brain circuits or nuclei.

Professor Jamie Tyler, at Arizona State University, has developed novel, non-invasive methods, systems, and devices for mechanically disturbing tissues, on mesoscopic length scales. While the CNS and brain tissues are of most interest, this system could be applied to other soft tissues including muscle, liver breast and others. These systems, methods, and devices produce micromechanical disturbances of brain nuclei and circuits in a spatially and temporally precise manner for characterization and interrogation of their mechanical properties, such as rigidity, stiffness, elasticity, and viscoelasticity. These methods, systems and devices can be used for the evaluation of tissue mechanical properties using known elastographic approaches such as MRE, shear wave elasticity imaging, vibroacoustography, and others.

Potential Applications

- Clinical Diagnostics for disease associated with changes in cellular elasticity
- Determining the mechanical properties of the brain and relating that to function and dysfunction
- Characterizing traumatic brain injury (TBI)

Benefits and Advantages

- Much simpler than current devices

- Improved spatial resolution – allows for more precise elastographic mapping and more detailed elastogram generation

- Can target discrete brain regions and brain circuits such that it can be conducted on nearly any brain region of interest

- The changes between the baseline shear and elastic moduli and those measured during activation will yield an unprecedented signature of how mechanical properties change across levels of neural activity

- Non-invasive

- Multiple discrete tissue regions can be targeted simultaneously or serially for rapid and discretized characterization of the mechanobiological properties of the tissue

For more information about the inventor(s) and their research, please see Dr. Tyler's laboratory webpage