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Short Communication
Published: 30 Mar, 2018

Journal of Physical and Rehabilitation Medicine Forecast

MRI-Guided Focused Ultrasound: A State-of-the-Art Technology for 21st Century Medicine

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Short Communication

New and promising medical discoveries and treatments are being reported on a near-daily basis. Few developments however have been as transformative and far-reaching as combining high-resolution magnetic resonance imaging (MRI) and noninvasive energy deposition using focused ultrasound (FUS) [1]. MRI-guided FUS (MRgFUS) continues to make headlines, where new indications for treatment are being developed at top medical and academic institutions world-wide. MRgFUS is a new and disruptive technology that enables the controlled, targeted application of ultrasound energy deep within the body in a noninvasive manner [2]. One of the unique characteristics of ultrasound energy is that it can be tuned to generate mechanical and/or thermal effects in tissues leading to a multitude of potential therapeutic benefits [3]. These include the direct creation of ablative lesions, activation of the immune system, and a host of transient and nondestructive structural effects that can alter tissue permeability for improved delivery of therapeutics. These range from small molecules to monoclonal antibodies, viral and non-viral gene vectors, nanoparticle drug carriers [3] and even cells [4-6]. Since its inception just over two decades ago, MRgFUS has gained FDA approval for thermal ablation of uterine fibroids, prostate and breast cancer, and palliative treatment of bone metastases [7]. It was recently approved for the treatment of essential tremor (ET), a debilitating neurological disorder caused by dysfunctional neural circuits that is currently treated with surgically-implanted deep brain electrodes [8]. The noninvasive MRgFUS procedure of ET involves transcranial exposures for the ablation of the ventricular intermediate nucleus (VIM), located within the thalamus. The ability to safely treat the VIM for ET has created the opportunity to apply ultrasound for other brain-related applications. These include enhancing the delivery of therapeutics to invasive brain tumors [9] and for inducing neurogenesis in patients with degenerative conditions such as Alzheimer's Disease [10]. Clinical trials for these and other pioneering applications are currently underway.

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Received Date: *22 Mar 2018*
Accepted Date: *29 Mar 2018*
Published Date: *30 Mar 2018*

Citation: *Frenkel V. MRI-Guided Focused Ultrasound: A State-of-the-Art Technology for 21st Century Medicine. J Phys Rehabil Med Forecast. 2018; 1(1): 1003.*

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