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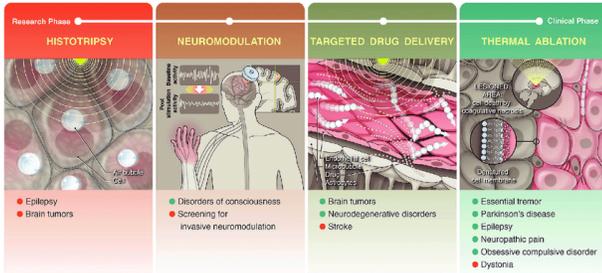
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### Current and Future Clinical Applications of Focused Ultrasound (FUS) Technology

Source publication



### A Review of the Current Therapies, Challenges, and Future Directions of Transcranial Focused Ultrasound Technology: Advances in Diagnosis and Treatment

Article Full-text available

Dec 2017

Vibhor Krishna · Francesco Sammartino · Ali Rezai

Importance Magnetic resonance imaging-guided focused ultrasound ablation has been approved for the treatment of refractory essential tremor and is being studied for other neurological indications, including dyskinesias and tremor in Parkinson disease, dystonia, neuropathic pain, obsessive-compulsive disorder, epilepsy, and brain tumors. Objective...

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## Contexts in source publication

### Context 1

... 1000 patients have been treated with FUS ablation worldwide. The Table 1-3,40,47-55 lists the historical timeline of FUS ablation applications in clinical neuroscience, especially for movement disorders (Figure ...

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### Context 2

... ability to transiently open blood-brain barrier in localized brain regions offers a promising route for targeted drug delivery (eg, chemotherapy for neuro-oncology 72 ; gene and neurotrophic factors for neurodegenerative diseases 73 ) ( Figure 3 ). Two clinical trials for chemotherapy delivery are currently recruiting participants for tumor application. Plaque clearance in animal models of Alzheimer disease was recently reported. 74 Using the scanning ultrasound technique, Leinenga and Götz 74 opened cortical blood-brain barrier at multiple locations, resulting in albumin-mediated plaque clearance in the transgenic rodent model of Alzheimer disease; human trial is also under way to investigate the safety of this approach. Finally, targeted drug delivery can be an attractive option for intravascular thrombolysis (eg, in distal intracranial thrombosis where endovascular therapy has met with ...

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## Similar publications

### **A meta-analysis of outcomes and complications of magnetic resonance-guided focused ultrasound in the treatment of essential tremor**

[Article](#)

Feb 2018

 Nasser Mohammed ·  Devi Prasad Patra ·

 Anil Nanda

OBJECTIVE Magnetic resonance–guided focused ultrasound (MRgFUS) is a novel technique that uses high-intensity focused ultrasound to achieve target ablation. Like a lens focusing the sun's rays, the ultrasound waves are focused to generate heat. This therapy combines the noninvasiveness of Gamma Knife thalamotomy and the real-time ablation of deep b...

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## Citations

... It consists of a "helmet-like" stereotactic frame and comprises 1024 transducers. The "low-frequency" version of the system operates around 220 kHz for BBB opening, while the "mid-frequency" version operates around 650 kHz for thermal ablation [167]. The cavitation needed for BBB opening is permitted by injection of Definity microbubbles, injected immediately before each treatment location, [168]. ...

### **Therapeutic ultrasound transducer technology and monitoring technique...**

[Article](#)

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Aug 2024 · INT J HYPERTHER

The exponential growth of therapeutic ultrasound applications demonstrates the power of the technology to leverage...

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... tFUS is an emerging, non-invasive neuromodulation tool for deep brain stimulation that has shown promise in treating various neurological and psychiatric conditions [14] [15][16]. Following its FDA approval for Parkinson's disease and essential

tremor, tFUS has seen significant advancements in clinical validation [17]. There is an increasing urgency to optimize tFUS therapeutic applications through expanding research. ...

### Neuromodulatory Responses Elicited by Intermittent Versus Continuous...

[Article](#)

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May 2024 · INT J MOL SCI

 Tsung-Hsun Hsieh · Po-Chun Chu · 

Thi Xuan Dieu Nguyen ·  Chi-Wei Kuo ·

Hao-Li Liu

Transcranial focused ultrasound stimulation (tFUS) has emerged as a promising neuromodulation technique...

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... LTRASOUND (US) is a versatile technology that is well-established as a safe and effective real-time bedside imaging modality. More recently, focused ultrasound (FUS) has emerged as an effective treatment modality for a multitude of applications and is under development as an intervention for various neurologic disorders, including immunomodulation, neuromodulation, blood-brain barrier opening, tumor ablation, and targeted drug delivery [1]. While there are many potential applications for diagnostic and therapeutic US in the intracranial space, the human skull reflects or absorbs a large amount of the ultrasonic energy [2][3][4]. ...

### Ultrasound-Guided Mechanical High-Intensity Focused Ultrasound...

[Article](#)

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May 2024 · IEEE T BIO-MED ENG

Lauren Ruger · Maya Langman · Renata Farrell · ● John H Rossmeisl · ● Eli Vlaisavljevich

Introduction: Histotripsy is a non-thermal focused ultrasound therapy in development for the non-invasive...

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... They can also be used to enhance cognitive performance, learning, and memory in healthy individuals [101][102][103]. These techniques involve applying different types of stimuli, such as ultrasounds, electric currents, magnetic fields, or drugs, to specific brain regions or networks, in order to alter their excitability, connectivity, or plasticity [104] [105][106][107] [108] [109][110] [111]. In this subtopic, we review four papers that explore the use of different neurostimulation techniques for brain modulation and therapy. ...

### **Innovation at the Intersection: Emerging Translational Research in...**

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May 2024

● Masaru Tanaka · ● Simone Battaglia · ● Lydia Giménez-Llort · Chong Chen · ● László Vécsei

The editorial explores the realm of emerging translational research in neurology and psychiatry, providing...

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... Emerging in the 1940s as a potential alternative to invasive intracranial procedures, MRI-guided focused ultrasound (MRgFUS) initially demonstrated focal lesioning in the central

nervous system of animal models [7]. These methods were first applied to humans with movement disorders but had to be initially paired with an open craniotomy to permit adequate energy to reach the desired intracranial target as well as to avoid damage to the skull and scalp [8]. Only after advancements in magnetic resonance imaging (MRI) thermometry and improvements in transducer design, allowing for real-time monitoring and controlled transmission of heat, was the procedure first recognized as safe and feasible for non-invasive applications [9][10][11]. ...

... Focused ultrasound waves at a high frequency act on the intended tissue by inducing rapid oscillation of fluid-filled microscopic cavities within the cell, shearing its membrane and adjacent organelles [13]. This mechanical energy is converted into heat, which can elevate the temperature at its focused target to 55-60 °C, thereby accomplishing thermal ablation through denaturation of cellular proteins and organelles [8, 14]. Nonlinear wave propagation also contributes to thermal effects [15]. ...

### **The role of focused ultrasound for pediatric brain tumors: current insight...**

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May 2024 · CHILD NERV SYST

Kelsi M. Chesney · Gregory F. Keating ·  
Nirali Patel ·  Lindsay Kilburn ·   
Hasan R. Syed

Introduction Focused ultrasound (FUS) is an innovative and emerging technology for the treatment of adult...

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... They can also be used to enhance cognitive performance, learning, and memory in healthy individuals [93,94]. These techniques involve applying different types of stimuli, such as ultrasounds, electric currents, magnetic fields, or drugs, to specific brain regions or networks, in order to alter their excitability, connectivity, or plasticity [95][96][97][98][99][100][101]. In this subtopic, we will review four papers that explore the use of different neurostimulation techniques for brain modulation and therapy. ...

### **Innovation at the Intersection: Emerging Translational Research in...**

Preprint

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Apr 2024

● Masaru Tanaka · ● Simone Battaglia · ● Lydia Giménez-Llort · Chong Chen · ● László Vecsei

The editorial explores the realm of emerging translational research in neurology and psychiatry, providing...

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... One of the major deterrents for the utilization of DBS as a neuromodulation treatment for psychiatric disorders is the invasiveness of the procedure, implantable hardware, and the need to maintain the device/hardware over the long term. Recently, with the evolution of technology, MR-guided focused ultrasound (MRgFUS) has emerged as an FDA approved thermal ablative treatment for patients with essential tremor (ET) and PD, who are otherwise

candidates for DBS and/or surgical treatment [119] [120] [121][122][123]. MRgFUS is a non-invasive method, which involves real-time MRI guidance and application of transcranial focused ultrasound and patient monitoring without a surgical incision or surgical hardware [119,120]. ...

... One of the major deterrents for the utilization of DBS as a neuromodulation treatment for psychiatric disorders is the invasiveness of the procedure, implantable hardware, and the need to maintain the device/hardware over the long term. Recently, with the evolution of technology, MR-guided focused ultrasound (MRgFUS) has emerged as an FDA approved thermal ablative treatment for patients with essential tremor (ET) and PD, who are otherwise candidates for DBS and/or surgical treatment [119][120] [121][122][123]. MRgFUS is a non-invasive method, which involves real-time MRI guidance and application of transcranial focused ultrasound and patient monitoring without a surgical incision or surgical hardware [119, 120] . Given the wider acceptance and positive results of high-intensity MRgFUS ablative treatment in movement disorders [124][125][126], MRgFUS ablative treatment explored for psychiatric disorders. ...

## Neurosurgical neuromodulation therapy for psychiatric disorders

[Article](#)

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Apr 2024 · NEUROTHERAPEUTICS

Manish Ranjan ·  James J. Mahoney ·  Ali R. Rezai

Psychiatric disorders are among the leading contributors to global disease burden and disability. A significant...

... Transcranial focused ultrasound (FUS) has become an FDA-approved treatment for neurological disorders such as essential tremor and tremordominant Parkinson's disease and is currently being tested for epilepsy [10], neuropathic pain [11], and psychiatric disorders [12]. While the existing FUS applications involve tissue ablation, the ability for BBBO (FUS-BBBO), combined with intravascular contrast agents (e.g. ...

... One of the main challenges of using ultrasound for blood-brain barrier disruption is the precise delivery of ultrasound energy through the skull. Delivery of ultrasound through the bones of the skull is complicated by substantial attenuation and distortion, resulting in low pressures reaching brain tissue and phase aberration, which can shift the target region [12]. With the aforementioned critical parameters in mind, different hardware and device designs have been developed to meet various clinical needs. ...

### **Current clinical investigations of focused ultrasound blood-brain barrier...**

[Article](#)[Full-text available](#)

Apr 2024 · NEUROTHERAPEUTICS

● Phillip G. Durham · Alexandra Butnariu · Rizk Alghorazi · Gianmarco Pinton · Paul A. Dayton

The blood-brain barrier (BBB) presents a formidable challenge in delivering therapeutic agents to the central...

... Physical neuro-modulation is a highly delicate process that requires precise spatial and temporal resolution in both the central and peripheral nervous systems. Ultrasound stimulation, a commonly used non-invasive technique in fracture repair and osteotomy, can achieve millimeter-scale manipulation of neurons in seconds [1][2][3] [4] [5]. ...

### **L-Type Calcium Channel Modulates Low-Intensity Pulsed Ultrasound-...**

[Article](#)

Mar 2024

● Wen-Yong Fan · Yi-Ming Chen · Yi-Fan Wang · Yu-Qi Wang · Lei Xue

As a noninvasive technique, ultrasound stimulation is known to modulate neuronal activity both in vitro and in viv...

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... Finally, our current model suggests that the inhibitory population's itinerancy could be modulated by electrically stimulating excitatory neurons such as the pyramidal neurons. This is especially important in the context of neuromodulation (Luan et al., 2014; Krishna et al., 2018; Cole et al., 2022). Targeting pyramidal neurons for neuromodulation is currently more feasible than targeting regionally local inhibitory neurons. ...

### **Biophysical modulation and robustness of itinerant complexity in neuronal...**

[Article](#)

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Mar 2024

● Siva Venkadesh · Asmir Shaikh ·  
Heman Shakeri · ● Ernest Barreto · ●  
John Darrell Van Horn

Transient synchronization of bursting  
activity in neuronal networks, which  
occurs in patterns of metastable...

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