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► To cite this version:

Andrew Drainville, David Moore, John Snell, Sylvain Chatillon, Cyril Lafon, et al.. Influence of bone properties on transcranial acoustic propagation using ray tracing numerical simulations. ISTU 2021 - International Symposium for Therapeutic Ultrasound, Jun 2021, Gyeongju, South Korea. , 2021. cea-04418213

HAL Id: cea-04418213

<https://cea.hal.science/cea-04418213>

Submitted on 25 Jan 2024

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Abstract Submission

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Preferred Presentation Type

Poster

Topic

Physics and Modelling

Paper Details

Influence Of Bone Properties On Transcranial Acoustic Propagation Using Ray Tracing Numerical Simulations

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Objective

For transcranial focused ultrasound therapy, acoustic energy is focused through the skull using a multi-element transducer. Using a ray-tracing numerical simulation method, a parametric study was conducted to examine the sensitivity of transcranial focalization

quality to variations in the skull's acoustic properties, as well as to the effects of shear mode conversion and acoustic resonance.

Methods

The parametric study was performed using a ray-tracing method with a model of the human skull and acoustic source based on the ExAblate Neuro 650kHz (Insightec) clinical system. The skull properties, including density, acoustic velocity, and degree of heterogeneity were varied, while focalization quality was quantified using the focal amplitude and spatial position. The use of a ray-tracing model allowed for the contributions of shear mode conversion and acoustic resonance in both homogeneous and multi-layer models of the skull to be examined directly.

Results

The results of this study quantified the sensitivity of the intracranial acoustic field to variations of skull density, acoustic velocity, and degree of heterogeneity. These findings illustrate how uncertainties in acoustic properties and increased heterogeneity can have deleterious effects on transcranial focusing.

Simulations indicate that shear mode conversion had an appreciable effect on focalization quality in both homogeneous and multi-layer models of the skull, while the contributions from acoustic resonance remained negligible.

Conclusion

This study quantified the sensitivity of transcranial focalization quality to uncertainties in acoustic properties of the human skull, and demonstrate the importance of considering skull heterogeneity and shear mode conversion in ray-tracing models of transcranial acoustic propagation.
