12TH INTERNATIONAL SYMPOSIUM ON THERAPEUTIC ULTRASOUND

Heidelberg, Germany 10 – 13 June 2012

EDITOR

Stephen Meairs Universitätsmedizin Mannheim University of Heidelberg, Mannheim, Germany

All papers have been peer reviewed.

SPONSORING ORGANIZATIONS

Philips

Focused Ultrasound Foundation

InSightec

Verasonics

Siemens

Precision Acoustics

Alpinion Medical Systems

National Physical Laboratory

Care Fusion

Imasonic

Sonic Concepts

Supersonic Imagine

Weidlinger Associates

Electronics & Innovations, Ltd.



Melville, New York, 2012
AIP I CONFERENCE PROCEEDINGS ■ 1503

Editor

Dr. Stephen Meairs
Department of Neurology
Universitätsmedizin Mannheim
University of Heidelberg
68167 Mannheim
Germany

E-mail: meairs@neuro.ma.uni-heidelberg.de

Authorization to photocopy items for internal or personal use, beyond the free copying permitted under the 1978 U.S. Copyright Law (see statement below), is granted by the American Institute of Physics for users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$30.00 per copy is paid directly to CCC, 222 Rosewood Drive, Danvers, MA 01923, USA: http://www.copyright.com. For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transactional Reporting Services is: 978-0-7354-1120-3/12/\$30.00.

© 2012 American Institute of Physics

No claim is made to original U.S. Government works.

Permission is granted to quote from the AIP Conference Proceedings with the customary acknowledgment of the source. Republication of an article or portions thereof (e.g., extensive excerpts, figures, tables, etc.) in original form or in translation, as well as other types of reuse (e.g., in course packs) require formal permission from AIP and may be subject to fees. As a courtesy, the author of the original proceedings article should be informed of any request for republication/reuse. Permission may be obtained online using RightsLink. Locate the article online at http://proceedings.aip.org, then simply click on the RightsLink icon/"Permissions/Reprints" link found in the article abstract. You may also address requests to: AIP Office of Rights and Permissions, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502, USA; Fax: 516-576-2450; Tel.: 516-576-2268; E-mail: rights@aip.org.

ISBN 978-0-7354-1120-3 (Original Print) ISSN 0094-243X Printed in the United States of America

AIP Conference Proceedings, Volume 1503 12th International Symposium on Therapeutic Ultrasound

Table of Contents

Preface: 12th International Symposium on Therapeutic Ultrasound Stephen Meairs	1
BIOEFFECTS OF THERAPEUTIC ULTRASOUND	
Effects of low-dose extracorporeal shock waves on microcirculation Walaa Khaled, Ole Goertz, Henrik Lauer, Marcus Lehnhardt, and Jörg Hauser	2
Effects of ultrasound upon endothelial cell ultrastructure Claus Rodemer, Jürgen Jenne, Marc Fatar, Michael G. Hennerici, and Stephen Meairs	7
Ultrasound fails to induce proliferation of human brain and mouse endothelial cell lines Claus Rodemer, Jürgen Jenne, Marc Fatar, Michael G. Hennerici, and Stephen Meairs	12
BLOOD-BRAIN BARRIER OPENING	
The safest parameters for FUS-induced blood-brain barrier opening without effects on the opening volume Yao-Sheng Tung, Yemi Olumolade, Shutao Wang, Shih-Ying Wu, and Elisa E. Konofagou	17
Non-human primate skull effects on the cavitation detection threshold of FUS-induced blood-brain barrier opening Shih-Ying Wu, Yao-Sheng Tung, Fabrice Marquet, Cherry C. Chen, and Elisa E. Konofagou	23
Neuronavigation-guided focused ultrasound-induced blood-brain barrier opening: A preliminary study in swine Hao-Li Liu, Hong-Chieh Tsai, Yu-Jen Lu, and Kuo-Chen Wei	29

Targeting accuracy and closing timeline of the microbubble-enhanced focused ultrasound blood-brain barrier opening in non-human primates Fabrice Marquet, Yao-Sheng Tung, Tobias Teichert, Shih-Ying Wu, Shutao Wang, Matthew Downs, Vincent P. Ferrera, and Elisa E. Konofagou	35
DRUG DELIVERY	
Irinotecan delivery by microbubble-assisted ultrasound - A pilot	
preclinical study Jean-Michel Escoffre, Anthony Novell, Sophie Serrière, and Ayache Bouakaz	40
A novel cardiac extracorporeal shock wave for enhancing the efficacy of	
cell therapy Walaa Khaled, Birgit Assmus, Andreas Lutz, Dirk Walter, David Leistner, Stefanie Dimmeler, and Andreas Zeiher	46
Enhancing laser thermal-therapy using ultrasound-microbubbles and gold nanorods: <i>In vitro</i> investigation Christine Tarapacki, Carl Kumaradas, and Raffi Karshafian	50
Improved luciferase gene expression using ultrasound targeted microbubble destruction therapy in swine Misty L. Noble, Shuxian Song, Ryan R. Sun, Luping Fan, Robert M. DiBlasi, Colleen O'Kelly-Priddy, Keith R. Loeb, and Carol H. Miao	55
A study on sonoporation of cells cultured on a soft collagen gel scaffold Nobuki Kudo and Yuto Kinoshita	61
MICROBUBBLES	
Microbubble-enhanced HIFU therapy: Effect of exposure parameters on	
thermal lesion volume and temperature Sonal Bhadane, Raffi Karshafian, and Jahan Tavakkoli	65
Numerical study on microbubble-enhanced heating for various	
parameters in EUS-FUS Kohei Okita, Miyuki Maezawa, Shu Takagi, and Yoichiro Matsumoto	71

An experimental study on the stiffness of size-isolated microbubbles using atomic force microscopy	
Cherry C. Chen, Shih-Ying Wu, John D. Finan, Barclay Morrison III, and Elisa E. Konofagou	77
MODELING	
Effects of acoustic nonlinearity and blood flow cooling during HIFU treatment	
Maxim A. Solovchuk, Tony W. H. Sheu, and Marc Thiriet	83
A Lattice-Boltzmann model to simulate diffractive nonlinear ultrasound beam propagation in a dissipative fluid medium	
Mohamad Abdi, Mojtaba Hajihasani, Shahriar Gharibzadeh, and Jahan Tavakkoli	89
Rapid 3D human ribcage and kidney modeling for transcostal HIFU surgery	
Rui Cao, Jing Gao, Andreas Melzer, Ghulam Nabi, and Zhihong Huang	95
Experimental validation of a method for the prediction of the acoustic field produced by an acoustic source and the reflected field produced by a solid interface	
Sandra Diaz, Rajiv Chopra, and Samuel Pichardo	101
An acoustic backscatter-based method for estimating attenuation towards monitoring lesion formation in high intensity focused	
ultrasound Siavash Rahimian and Jahan Tavakkoli	107
MONITORING	
Characterization of HIEL ablation using DNA for amountation labeling as	
Characterization of HIFU ablation using DNA fragmentation labeling as apoptosis stain	
Jeremie Anquez, Jean-Michel Corréas, Bernard Pau, François Lacoste, and Sylvain Yon	113
Assessment of HIFU lesions by shear-wave elastography: Initial in-vivo	
results Jeremie Anquez, Jean-Michel Corréas, Aline Criton, François Lacoste, and Sylvain Yon	118

Dual-mode ultrasound arrays for image-guided targeting of atheromatous plaques	
John R. Ballard, Andrew J. Casper, Dalong Liu, Alyona Haritonova, Islam A. Shehata, Mitchell Troutman, and Emad S. Ebbini	124
Monitoring the lesion formation during histotripsy treatment using shear wave imaging	
Bastien Arnal, Wei-Ning Lee, Mathieu Pernot, Mathias Fink, and Mickael Tanter	129
Organ motion tracking in USgFUS - A feasibility study using sonoelastography	
X. Xiao, N. Le, G. Corner, G. Nabi, A. Melzer, and Z. Huang	135
Multi-parametric monitoring of high intensity focused ultrasound (HIFU) treatment using harmonic motion imaging for focused ultrasound (HMIFU)	
Gary Y. Hou, Fabrice Marquet, Shutao Wang, and Elisa Konofagou	140
MR-GUIDED FOCUSED ULTRASOUND	
Optimizing sonication protocols for transthoracic focused ultrasound	
surgery J. Gao, A. Volovick, R. Cao, G. Nabi, S. Cochran, A. Melzer, and Z. Huang	146
Robotically assisted velocity-sensitive triggered focused ultrasound surgery	
Florian Maier, Alexander Brunner, Jürgen W. Jenne, Axel J. Krafft, Wolfhard Semmler, and Michael Bock	152
MatMRI and MatHIFU: Matlab{trade mark, serif} toolboxes for real- time monitoring and control of MR-HIFU	
Tony Sinclair, Charles Mougenot, Jon Kivinen, and Samuel Pichardo	156
Rapid HIFU autofocusing using the entire MR-ARFI image William A. Grissom, Elena Kaye, Kim Butts Pauly, Yuval Zur, Desmond	
Yeo, Yoav Medan, and Cynthia Davis	162
Metabolic changes after MRgFUS treatment of a bone metastasis using PET/CT: A case report	
Giuliana Candiano, Giorgio Russo, Alessandro Stefano, Lorenza Marino, Francesca Ganguzza, Arturo Vaccari, Vincenzo Tripoli, Anna Galluzzo, Sabina Pulizzi, Domenico Messana, Giovanni Borasi, Cristina Messa, and	
Maria Carla Gilardi	168

Treatment of localized abscesses induced by methicillin-resistant Staphylococcus aureus (MRSA) using MRgFUS: First in vivo results Birgit Rieck, Laura Curiel, Charles Mougenot, Kunyan Zhang, and	
Samuel Pichardo	173
Custom molded thermal MRg-FUS phantom Matthew D. C. Eames, John W. Snell, Arik Hananel, and Neal F. Kassell	179
Intracranial treatment envelope mapping of transcranial focused	
ultrasound Matthew D. C. Eames, Arik Hananel, Neal F. Kassell, and John W. Snell	181
Transcranial phase aberration correction using beam simulations and	
MR-ARFI Urvi Vyas, Elena Kaye, and Kim Butts Pauly	185
Evaluation of intensity based beam-shaping method with Rib-phantom	
HIFU sonications Matti Tillander, Max Köhler, Julius Koskela, and Mika Ylihautala	191
Effects of human hair on trans-cranial focused ultrasound efficacy in an	
ex-vivo cadaver model Arik Hananel, John W. Snell, Neal F. Kassell, and Matthew D. C. Eames	195
Combined magnetic resonance imaging and ultrasound echography	
guidance for motion compensated HIFU interventions Mario Ries, Baudouin Denis de Senneville, Yvan Regard, and Chrit	
Moonen	202
MRI-controlled interstitial ultrasound brain therapy: An initial in-vivo study	
W. Apoutou N'Djin, Mathieu Burtnyk, Nir Lipsman, Michael Bronskill, Michael Schwartz, Walter Kucharczyk, and Rajiv Chopra	207
Dual-frequency ultrasound focal therapy for MRI-guided transurethral	
treatment of the prostate: Study in gel phantom W. Apoutou N'Djin, Charles Mougenot, Ilya Kobelevskiy, Elizabeth	
Ramsay, Michael Bronskill, and Rajiv Chopra	212
Robotic active positioning for magnetic resonance-guided high-intensity focused ultrasound	
Xu Xiao Zhihong Huang Alexander Volovick and Andreas Melzer	217

Dynamic T ₂ -mapping during magnetic resonance guided high intensity	
focused ultrasound ablation of bone marrow Adam C. Waspe, Thomas Looi, Charles Mougenot, Joao Amaral,	
Michael Temple, Siv Sivaloganathan, and James M. Drake	222
r .,,,	
SONOTHROMBOLYSIS	
Clot dissolution is better with ultrasound assisted thrombolysis for fresh clots with higher cholesterol content	
Yufeng Zhou, Vijay Kumar Sharma, Kanna Suresh Murugappan, and Aftab Ahmad	227
Porcine pilot study of MRI-guided HIFU treatment for neonatal intraventricular hemorrhage (IVH)	
Thomas Looi, Adam Waspe, Charles Mougenot, Joao Amaral, Michael Temple, Kullervo Hynynen, and James Drake	233
Risk reduction of brain infarction during carotid endarterectomy or stenting using sonolysis - Prospective randomized study pilot data Martin Kuliha, David Školoudík, Martin Martin Roubec, Roman Herzig, Václav Procházka, Tomáš Jonszta, Jan Krajča, Dan Czerný, Tomáš Hrbáč, David Otáhal, and Kateřina Langová	239
In vitro sonothrombolysis of human blood clots with BR38 microbubbles Yannick Bohren, Emmanuel Gaud, Marcel Arditi, Thierry Bettinger, François Tranquart, and Feng Yan	244
Investigating the interaction between acoustically stimulated microbubbles and fibrin clots	
Christopher Acconcia, Ben Leung, Kullervo Hynynen, and David Goertz	250
Transcranial measurements of the acoustic field produced by a low	
frequency focused ultrasound system Arne Voie, David Fisher, Golnaz Ahadi, and Thilo Hölscher	256
TRANSDUCERS AND DEVICES	
Toroidal transducer with two large focal zones for increasing the coagulated volume	
J. Vincenot, D. Melodelima, A. Kocot, F. Chavrier, and J. Y. Chapelon	264

Optimal patterns for sequentially multiple focusing in high intensity focused ultrasound and their application to thermal dose Mun-Bo Shim, Hyoungki Lee, Hotaik Lee, Junho Park, and Minsu Ahn	270
On the reliability of voltage and power as input parameters for the characterization of high power ultrasound applications Julian Haller and Volker Wilkens	276
New piezocrystal material in the development of a 96-element array transducer for MR-guided focused ultrasound surgery Zhen Qiu, Roderick Habeshaw, Julien Fortine, Zhihong Huang, Christine Démoré, and Sandy Cochran	282
High intensity ultrasound transducer used in gene transfection Kyle P. Morrison, George W. Keilman, Misty L. Noble, Andrew A. Brayman, and Carol H. Miao	288
TUMOR TREATMENT	
High-intensity focused ultrasound (HIFU) using Sonablate{trade mark, serif} devices for the treatment of localized prostate cancer: 13-year experience	
Toyoaki Uchida, Tetsuro Tomonaga, Sunao Shoji, Hakushi Kim, and Yoshihiro Nagata	293
Analysis of the fast scanning method for tumor ablation with the effect of the large blood vessel by numerical simulation	
Shan Qiao, Guofeng Shen, Jingfeng Bai, and Yazhu Chen	300
Robotic high-intensity focused ultrasound (rHIFU) for the prostate cancer treatment	
Vyacheslav Solovov, Leonid Shaplygin, and Mikhail Vozdvizhenskiy	305
Clinical phase I/II research on ultrasound thermo-chemotherapy in oral and maxillofacial-head and neck carcinoma	
Guofeng Shen, Guoxin Ren, Wei Guo, and Yazhu Chen	311
Author Index	315