19th Internarional Symposium of ISTU
5th European Symposium of EUFUS

Barcelona 2019 | 13th - 15th June

ABSTRACT BOOK

EUFUS
ISTU
KHUAB COMPREHENSIVE TUMOR CENTER BARCELONA
Hospital Universitari MútuaTerrassa
UNIVERSITAT DE BARCELONA

ORGANIZING COMMITEE

Scientific Organizing Committee

Robin Cleveland, *Co-Chair*

Vera Khokhlova, *Co-Chair*

Local Organizing Committee

Joan Vidal-Jové, *Chair*

EUFUS Organizing Committee

Andreas Melzer, *Co-Chair*

Wladyslaw Gedroyc

Alessandro Napoli

Matthias Matzko

Lisa Landgraf

ISTU

Joo Ha Hwang, President

Kim Butts Pauly, Secretary General

Jean-François Aubry

Gail ter Haar

MAPPING CLINICAL HIFU THERMAL TISSUE ABLATION USING SIMULATION AND MR-IMAGING

M.M. Karzova[1], W. Kreider[2], A. Partanen[3], O.A. Sapozhnikov[1,2], T.D. Khokhlova[4], P.V. Yuldashev[1], and V.A. Khokhlova[1,2]

[1]Physics Faculty, M.V. Lomonosov Moscow State University, Moscow, Russia
[2]Center for Industrial and Medical Ultrasound, University of Washington, Seattle, USA
[3]Clinical Science, Profound Medical Inc., Mississauga, ON, Canada
[4]Division of Gastroenterology, School of Medicine, University of Washington, Seattle, WA
e-mail: masha@acs366.phys.msu.ru

OBJECTIVES

Clinical MR–guided HIFU is typically applied using strategies that rely on linear ultrasound propagation and heat diffusion to create a uniform ablation zone. In this study, a model for HIFU tissue heating and ablation was developed and validated by comparing the predictions to MR thermometry images obtained during HIFU ablation and to photographs of ablated tissue volumes.

METHODS

The linearized 3D Westervelt equation with boundary conditions obtained from holography measurements was used to simulate acoustic heat sources in tissue. These heat sources were further used with the bioheat equation to simulate temperature fields and volumetric tissue ablation based on a thermal dose of 1.76 seconds at 56°C. Simulations and experiments in *ex vivo* bovine liver on the Sonalleve V2 clinical MR-HIFU system (Profound Medical Inc., Canada) were performed for 1.2 MHz HIFU exposures at 200 W acoustic power, CW irradiation, and trajectories of 24 discrete foci located on concentric rings with radii of 2 and 4 mm. MR temperature maps were acquired during HIFU exposures using the proton resonance frequency shift thermometry method.

RESULTS

MR-based temperature maps and simulations were in good agreement for the dimensions and values of the temperature distributions in tissue for both sagittal (Fig. a) and coronal (b) planes. In addition, the numerically calculated lesion volume of 785 mm^3 matched the ablated volume in gross lesion photograph (c), resulting in ablation speed of 2.4 cm^3/min.

CONCLUSIONS

A numerical model to predict linear HIFU tissue heating and ablation was developed and validated for use. The model may further allow development and characterization of nonlinear pulsed shock wave exposures with high peak power and low duty cycle to create more precise, predictable, and heat diffusion-independent ablation volumes on clinical HIFU systems.

ACKNOWLEDGEMENTS

Supported by FUSF and NIH R01EB007643.

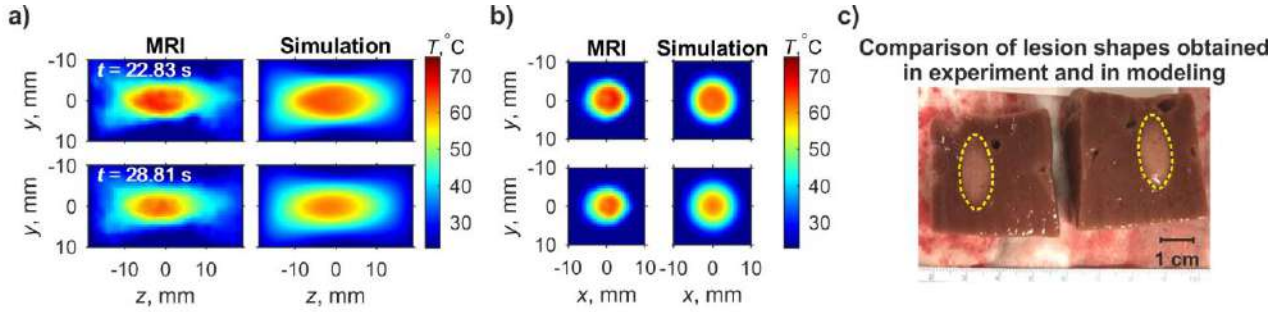

FIGURE CAPTION: Temperature distribution in *ex vivo* bovine liver assessed by MR thermometry and simulation in sagittal (a) and coronal (b) planes at 22.8 s and 28.8 s. (c) Thermal lesions in *ex vivo* bovine liver with superimposed contour of numerically simulated ablated region.