

Evidence for the Molecular, Cellular and Physiological Effects of Microstreaming and Cavitation at MHz and kHz Ultrasound Frequencies

Professor Tim Watson

University of Hertfordshire, UK

T.Watson@herts.ac.uk

www.electrotherapy.org

References

- Baker, K. G., V. J. Robertson, et al. (2001). "A review of therapeutic ultrasound: biophysical effects." Physical Therapy **81**(7): 1351-8.
- Barnett, S. B. (2003). "Key issues in the analysis of safety of diagnostic ultrasound." ASUM ULTRASOUND BULLETIN **6**(3): 41-43.
- Barnett, S. B. and D. Maulik (2001). "Guidelines and recommendations for safe use of Doppler ultrasound in perinatal applications." J Matern Fetal Med **10**(2): 75-84.
- Brujan, E. A. (2004). "The role of cavitation microjets in the therapeutic applications of ultrasound." Ultrasound Med Biol **30**(3): 381-387.
- Clarke, L., A. Edwards, et al. (2004). "Acoustic streaming: an in vitro study." Ultrasound Med Biol **30**(4): 559-62.
- Duck, F. A. (2008). "Ultrasound dose and interactions with tissue : <http://brachytherapy.casaccia.enea.it/meetingsDocuments.php>." 2008.
- Edmonds, P. D. and K. M. Sancier (1983). "Evidence for free radical production by ultrasonic cavitation in biological media." Ultrasound in Med & Biol **9**(6): 635-639.
- Fong, S. W., E. Klaseboer, et al. (2006). "Numerical analysis of a gas bubble near bio-materials in an ultrasound field." Ultrasound Med Biol **32**(6): 925-42.
- Forbes, M. M. (2008). "Sonoporation : <http://www.brl.uiuc.edu/Projects/sonoporation.php>."
- Johns, L. D. (2002). "Nonthermal effects of therapeutic ultrasound: the frequency resonance hypothesis." J Athletic Train: Athletic-Train.
- Krasovitski, B. and E. Kimmel (2004). "Shear stress induced by a gas bubble pulsating in an ultrasonic field near a wall." IEEE Trans. Ultrason. Ferroelectr. Freq. Control **51**(8): 973-979.
- Meairs, S. and A. Alonso (2007). "Ultrasound, microbubbles and the blood-brain barrier." Prog Biophys Mol Biol **93**(1-3): 354-62.

- Miller, D. L. (1987). "A review of the ultrasonic bioeffects of microsonation, gas body activation and related cavitation like phenomena." Ultrasound in Medicine & Biology **13**(8): 443-470.
- Miller, D. L. (2007). "Overview of experimental studies of biological effects of medical ultrasound caused by gas body activation and inertial cavitation." Prog Biophys Mol Biol **93**(1-3): 314-30.
- Miller, D. L., R. A. Gies, et al. (1997). "Ultrasonically induced hemolysis at high cell and gas body concentrations in a thin-disc exposure chamber." Ultrasound Med Biol **23**(4): 625-33.
- Miller, M. W., D. L. Miller, et al. (1996). "A review of in vitro bioeffects of inertial ultrasonic cavitation from a mechanistic perspective." Ultrasound Med Biol **22**(9): 1131-54.
- Ogurtan, Z., I. Celik, et al. (2002). "Effect of experimental therapeutic ultrasound on the distal antebrachial growth plates in one-month-old rabbits." Vet J **164**(3): 280-7.
- Okada, K., N. Kudo, et al. (2005). "A basic study on sonoporation with microbubbles exposed to pulsed ultrasound." Journal of Medical Ultrasonics **32**: 3-11.
- Riesz, P. and C. L. Christman (1986). "Sonochemical free radical formation in aqueous solutions." Federation Proc **45**: 2485-2492.
- Schlicher, R. K., H. Radhakrishna, et al. (2006). "Mechanism of intracellular delivery by acoustic cavitation." Ultrasound Med Biol **32**(6): 915-24.
- Shi, X., R. W. Martin, et al. (2002). "Quantitative investigation of acoustic streaming in blood." J Acoust Soc Am **111**(2): 1110-21.
- ter Haar, G. (2007). "Therapeutic applications of ultrasound." Prog Biophys Mol Biol **93**(1-3): 111-29.
- Uhlemann, C., B. Heinig, et al. (2003). "Therapeutic ultrasound in lower extremity wound management." Int J Low Extrem Wounds **2**(3): 152-7.
- VanBavel, E. (2007). "Effects of shear stress on endothelial cells: possible relevance for ultrasound applications." Prog Biophys Mol Biol **93**(1-3): 374-83.
- Wu, J. (2007). "Shear stress in cells generated by ultrasound." Prog Biophys Mol Biol **93**(1-3): 363-73.