On ultrasound classification of stroke risk factors from randomly chosen respondents using non-invasive multispectral ultrasonic brain measurements and adaptive profiles

Miroslaw Wrobel[1], Andrzej Dabrowski, Adam Kolany
SoNovum AG, Leipzig, Germany
Anna Olak Popko
MTZ Clinical Research, Warsaw, Poland
Robert Olszewski
Department of Cardiology and Internal Medicine, Military Institute of Medicine. Warsaw, Poland
Pawel Karlowicz
Sonomed sp. Z o. o., Warsaw, Poland

Abstract

In this paper, we present a new brain diagnostic method based on a Computer Aided Multispectral Ultrasound Diagnostics method (**CAMUD**). We explored the standard values of the relative time of flight, **RIT,** as well as the attenuation, **ATN,** of multispectral longitudinal ultrasound waves propagated non-invasively through the brains of a standard Caucasian volunteer population across different ages and genders. For the interpretation of the volunteers health questionnaire and ultrasound data we explored various clustering and classification algorithms, such as **PCA** and **ANOVA**. We showed that the **RIT**'s and **ATN**'s provide very good estimators of possible physiological changes in the brain tissue and can differentiate the possible high-risk groups obtained by other groups and methods (Russo C.A., Ho K., Elixhauser A., 2007; Lloyd-Jones D. et. al., 2009).

Special attention should be given to the subgroup which included almost 39% of the volunteers. Respondents in this group have a significantly increased minimum **ATN** value (see Classification tree). These values are strongly correlated with the identified risk of stroke factors being: age, increased alcohol consumption, cases of heart disease and stroke in the family as already shown by Rusco and as incorporated into Lloyd-Jones D., et. al., "Heart Disease and Stroke Statistics - 2009 Update", by the American Heart Association (AHA) and American Stroke Association (ASA), as updated recently in the 2015 "Stroke Prevention Guidelines".

Keywords: ultrasounds, dispersion, brain, atrial fibrillation, stroke.

Acknowledgements

SoNovum AG wants to express its deep gratitude to the Development Bank of Saxony (**SAB**) with all its attention for supporting our efforts in fundamental research and developing of this new diagnostic method, **ECHO II**, with **EFRE** Grant **No.100109012/990.301573.3**.

[1]Corresponding author: miroslaw.wrobel@sonovum.de ; phone: +4934139299512

References

[1] Russo C.A., Ho K., Elixhauser A., *"Hospital Stays for Circulatory Diseases, 2004. Rockville, Md"*, **Agency for Healthcare Research and Quality, February 2007**

[2] Lloyd-Jones D., et. al., *"A Report From the American Heart Association Statistics Committee and Stroke Statistics Subcommittee"*, **Heart Disease and Stroke Statistics - 2009 Update**,

[3] Medscape, *New Stroke Prevention Guidelines: A Quick and Easy Guide.* , **Jan 16, 2015.**

[4] Mazur R., *"Dynamics of brain density in the acute phase of ischemic stroke"*, **Udar Mózgu**, **2002, tom 4 nr 1, 1-8**,

[5] O'Donnel M., Jayess E.T. and Miller J.G., *"Kramers-Kronig relationship between ultrasonic attenuation and phase velocity"*, **J. Acoust. Soc. Am. 69(3), March 1981**

[6] M. Wrobel: *"Advanced Ultrasonic Interferometer and Method of Non-Linear Classification and Identification of Mater using the same"*, **WO 2007/000047, June 28, 2005.**

[7] Zoni-Berisso et al. *"Clinical Epidemiology"* , **2014:6, 213-19**

[8] Haeusler K.G. et al. *"Brain MRI to personalise atrial fibrillation therapy: current evidence and perspectives"*, **Heart. 2014 Jun 20.**

[9] Oh Young Bang et al *"Evaluation of Cryptogenic Stroke With Advanced Diagnostic Techniques Stroke"*, **2014;45:1186-1194**

[10] Saito T., Kawamura Y., Tanabe Y., Asanome A., Takahashi K., Sawada J., Katayama T., Sato N., Aizawa H., Hasebe N., *"Cerebral microbleeds and asymptomatic cerebral infarctions in patients with atrial fibrillation"*, **J. Stroke Cerebrovasc Dis. 2014 Jul; 23(6):1616-22.**

[11] Fisher M., *"MRI screening for chronic anticoagulation in atrial fibrillation."*, **Front Neurol. 2013 Oct 4; 4:137**

[12] Kobayashi A., Iguchi M., Shimizu S., Uchiyama S., *"Silent cerebral infarcts and cerebral white matter lesions in patients with nonvalvular atrial fibrillation"*, **J. Stroke Cerebrovasc Dis, Volume: 21, (2012), pp. 310—317**

[13] Gage B.F., Waterman A.D., Shannon W., et al. *"Validation of clinical classification schemes for predicting stroke: results from the National Registry of Atrial Fibrillation"*, **JAMA 2001;285:2864-2870**

[14] Tatu L., Moulin T., Bogousslavsky J., Duvernoy H., *"Arterial territories of humanbrain: brainstem and cerebellum"*, **Neurology 1996;47(5):1125–35.**

[15] Tatu L., Moulin T., Bogousslavsky J., Duvernoy H., *"Arterial territories of the humanbrain: cerebral hemispheres"*, **Neurology 1998;50(6):1699–708.**

[16] Jodłowski L., *"Pomiar fazy sygnału harmonicznego z zastosowaniem niskich częstotliwości próbkowania"*, conference materials, **27th Winter School on Molecular and Quantum Acoustics, Ustroń 23-27/02/1998**.

[17] Szostakowski M., Jodłowski L., *"Measurements of Changes of Phase Velocity in a Fluid Using Digital Signal Processing"*, conference materials, **27th Winter School on Molecular and Quantum Acoustics, Ustroń 23-27/02/1998**.