EUROSON 2013

Young Investigator Award Winner David Maresca

Award Winner
David Maresca

David Maresca was born in Paris on June 16, 1983. He followed his secondary education at the Lycée Claude Monet from 1994 to 2001. In 2003, he started his university education in Physics at the University Paris Diderot. In the frame of his studies, he completed various assignments at the interface of physics and other disciplines such as astronomy (Hα kinematics of isolated galaxies), journalism (brief news items for Sciences et Avenir magazine), philosophy (epistemology, evolutionary theories), art (pigment analysis of the Mona Lisa with near infrared spectroscopy) and medicine (transcranial hyperthermia with ultrasound). He received a Master of Science in Ultrasound Physics in 2007 after the completion of his master's thesis, entitled "Single element ultrasonic imaging based on a variable refractive structure", at Philips High Tech Campus, Eindhoven, the Netherlands. Subsequently, he was appointed for a year as research scientist in experimental echocardiography at Philips Research and co-authored a patent on an acoustic fluid lens for ultrasound imaging. In October 2008, he joined the Thorax Centre Department of Biomedical Engineering of Erasmus University Medical Centre, Rotterdam, the Netherlands, to carry out a PhD in harmonic intravascular ultrasound imaging under the supervision of Nico de Jong and Antonius F. W. van der Steen. In August 2013 he started a postdoctoral fellowship in ultrafast echocardiography at the Institut Langevin, Paris, France.

Abstract - Imaging Microvasculature with Contrast Enhanced Ultraharmonic Ultrasound

David Maresca[1], Ilya Skachkov[1], Guillaume Renaud1, Krista Jansen[1,2], Gijs van Soest1, Nico de Jong[1,2,3], Antonius F. W. van der Steen[1,2,3]

[1]Thorax Centre Department of Biomedical Engineering, Erasmus University Medical Centre, Rotterdam, the Netherlands

[2]Interuniversity Cardiology Institute of the Netherlands, Utrecht, the Netherlands

[3]Imaging Science and Technology Department, Delft University of Technology, Delft, the Netherlands

Atherosclerotic plaque neovascularization was shown to be one of the strongest predictors of future cardiovascular events [1]. Yet, the clinical tools for coronary wall microvasculature detection in vivo are lacking. Here we report a contrast-enhanced ultrasound pulse sequence capable of detecting microvasculature invisible in conventional intracoronary imaging.
Our approach consisted in imaging contrast microbubbles using first order ultraharmonics that arise at 1.5 times the transmit frequency. These signals are specific to the ultrasound contrast agent, preventing non-linear propagation artefacts, and can be captured with a transducer frequency bandwidth of 40%. The ultrasound pulse sequence consisted in pairs of phase inverted chirp excitations (26 MHz center frequency). The ultraharmonic content was extracted by summing A-lines acquired in response to the pairs of inverted excitations. Subsequently, the residual data was digitally filtered in the ultraharmonic band (centered at 39 MHz). We implemented the pulse sequence on an intravascular ultrasound probe (transducer bandwidth < 60%), and acquired images of the respiratory microvasculature of a 6 days old chicken embryo. Microvessels exhibited cross sections of the order of human atherosclerotic plaque neovascularization (diameters < 200 µm).
In conventional intravascular ultrasound (IVUS) images, we could not disentangle

Dates

- 16 June 1983 Birth in Paris, France.
- 2001 Baccalauréat Scientifique, Lycée Claude Monet, Paris, France.
- 2001-2003 Classes préparatoires Physique, Chimie, Sciences de l'Ingénieur, Lycée Pierre-Gilles de Gennes – ENCPB, Paris, France.
- 2003 Entered the Magistère de Physique program of the University Paris Diderot, Paris, France.
- 2004 Exchange program at the University of New South Wales, Sydney, Australia.
- 2007 Master of Science in Ultrasound Physics of the University Paris Diderot.
- Magistère de Physique of the University Paris Diderot.
- 2007-2008 Research Scientist in Experimental Echocardiography at Philips Research, Eindhoven High Tech Campus, the Netherlands.
- 2008-2012 PhD in Experimental Echocardiography at the Thorax Centre Department of Biomedical Engineering, Erasmus University Medical Centre, Rotterdam, the Netherlands.
- October 2013 Young Investigator Award of the 25th EUROSON Congress, Stuttgart, Germany

microvessels from the connective tissue. On the contrary, ultraharmonic IVUS images successfully captured the ultrasound contrast agent spreading in the microvasculature. We confirmed experimentally the presence of an ultraharmonic frequency peak generated by the ultrasound contrast agent. Quantitatively, the contrast to tissue ratio between a microvessel and adjacent connective tissue was up to doubled (12.5 dB in ultraharmonic IVUS as opposed to 6 dB in conventional IVUS). For reference, a photograph of the microvasculature insonified with IVUS was acquired. It matched the ultraharmonic IVUS image with a strong agreement.

Contrast-enhanced ultraharmonic ultrasound revealed microvasculature invisible in conventional IVUS, clearing way towards a translation of the method to coronary plaque noevascularization detection in humans.

[1] W. E. Hellings, W. Peeters, F. L. Moll, S. R. D. Piers, J. van Setten, P. J. Van der Spek, J. de Vries, K. A. Seldenrijk, P. C. De Bruin, A. Vink, E. Velema, D. P. V. de Kleijn, G. Pasterkamp, Composition of Carotid Atherosclerotic Plaque Is Associated With Cardiovascular Outcome A Prognostic Study. Circulation 121, 1941-U1111 (2010).