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In vitro microemboli classification using neural network models and RF signals

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Abstract: Emboli classification is of high clinical importance for selecting appropriate treatment for patients. Several ultrasonic (US) methods using Doppler processing have been used for emboli detection and classification as solid or gaseous matter. We suggest in this experimental study exploiting the Radio-Frequency (RF) signal backscattered by the emboli since they contain additional information on the embolus than the Doppler signal. The aim of the study is the analysis of RF signals using Multilayer Perceptron (MLP) and Radial-Basis Function Network (RBFN) in order to classify emboli. Anthares scanner with RF access was used with a transmit frequency of 1.82 MHz at two mechanical indices (MI) 0.2 and 0.6. The mechanical index is given as the peak negative pressure (in MPa) divided by the square root of the frequency (in MHz). A Doppler flow phantom was used containing a 0.8 mm diameter vessel surrounded by a tissue mimicking material. To imitate gas emboli US behaviour, Sonovue microbubbles were injected at two different doses (10ll and 5ll) in a nonrecirculating at a constant flow. The surrounding tissue was assumed to behave as a solid emboli. In order to mimic real clinical pathological situations, Sonovue concentration was chosen such that the fundamental scattering from the tissue and from the contrast were identical. The amplitudes and bandwidths of the fundamental and the 2nd harmonic components were selected as input parameters to the MLP and RBFN models.Moreover the frequency bandwidths of the fundamental and the 2nd harmonic echoes were approximated by Gaussian functions and the coefficients were used as a third input parameter to the neural network models. The results show that the Gaussian coefficients provide the highest rate of classification in comparison to the amplitudes and the bandwidths of the fundamental and the 2nd harmonic components. The classification rates reached 89.28% and 92.85% with MLP and RBFN models respectively. This short communication demonstrates the opportunity to classify emboli based on a RF signals and neural network analysis.

Keywords : Microemboli, Gaseous embolus, Solid embolus, RF signals, Neural Network