Pulse wave parameters based on wave derivatives gained via impedance separation

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Quantification of pulse waves in the human cardiovascular system traditionally focused on pressure measurements, but flow curves might contain additional information. In a transmission model of the arterial system, the aortic pressure and flow can be described as the sum of forward and backward travelling waves. For the separation of the measured pressure and flow, both signals are needed, and it can be performed in the frequency (impedance separation) or time domain. The aim of this study is to show that parameters assigned to wave intensity analysis which are based on the first derivative of the signals and therefore usually gained in a time domain separation, can also be achieved via impedance separation.

In a study population of 148 patients, pressure and flow curves were measured non-invasively using tonometric and ultrasound techniques. Wave intensity is the product of the changes in pressure and flow and can be calculated for forward and backward travelling waves. To quantify wave intensity, areas under the intensity curves assigned to compression waves can be calculated.

The areas under the forward and backward compression waves are derived in two ways: The classical wave intensity method performs wave separation in the time domain. The impedance separation method operates in the frequency domain, the resulting waves are differentiated afterwards to gain the wave intensity. Correlations between the two methods for the area under the forward travelling compression wave of R=0.99 and for the area under the backward travelling compression wave of R=0.96 are obtained.

This comparison of the two methods shows that the impedance method as well as the wave intensity method can be used for wave separation with comparable results, even for parameters based on the differentiation of the signals, which are up to now solely gained via time domain separation.