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Retinal vessel diameter variations and their correlation to arterial blood pressure

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Footnotes

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Abstract

Purpose : The risk for cardiovascular diseases can be evaluated by the measuring of the retinal blood vessel diameters. Temporal variations in vessel diameter lead to uncertainties. Mayer waves are cyclic variations in cardiovascular system, which can be seen in arterial blood pressure. A link to retinal vessel diameters is known in general but temporal dependencies are not described yet. We investigated the similarity of these variations and determined the temporal dependencies in a multimodal measurement study.

Methods : In a study in accordance with the Declaration of Helsinki we performed measurements on 15 young and healthy subjects. Within a time period of 90 minutes, six repeated measurements with a duration of six minutes each were conducted.
We did a simultaneous measurement of retinal vessel diameters (Dynamic Vessel Analyzer, IMEDOS Systems UG, Jena, Germany) and non-invasive continuous arterial blood pressure (Finometer Pro, Finapres Medical Systems B.V., Enschede, The Netherlands). The sum of the diameters was calculated for both arteries and veins. We extracted waves in Very Low Frequency range (VLF, 0.02–0.07Hz) and Low Frequency range (LF, 0.07–0.15Hz) by filtering and determined temporal dependencies between both modalities using cross correlation. We extracted the lags of best signal correlation and calculated statistical parameters.

Results : Cross correlation analysis showed clear dependencies in most of the 90 datasets. The strongest correlations were in VLF: minima of arteries: median -3.68 s, Interquartile range (IQR) 3.57, minima of veins: median -5.89 s, IQR 3.85 and in LF: minima of arteries: median -3.95 s, IQR 3.29, maxima of veins: median -0.10 s, IQR 0.98. Negative time lags mean retinal vessel diameter follows blood pressure signal. Distribution of the time shifts in LF was much closer than in VLF. Most of the outliers were shifted by one period. Correlation coefficients ranged up to 0.82 for frequencies in VLF and up to 0.94 in LF, randomly shifted outliers had lower correlation coefficients up to 0.4. Most outliers were concentrated on a few subjects.

Conclusions : Our study showed clear dependencies between variations in retinal vessel diameter and arterial blood pressure. The best correlation could be seen in VLF on minima of arteries and veins and in LF on minima of arteries and maxima of veins, yielding the smallest variation in time shift and the smallest number of outliers.

This is an abstract that was submitted for the 2018 ARVO Annual Meeting, held in Honolulu, Hawaii, April 29 - May 3, 2018.