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Dynamic vessel analysis using LED illumination and stimulation

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Abstract

Purpose : Dynamic vessel analysis (DVA) with the Retinal Vessel Analyzer (Imedos Systems UG) is the Gold standard to measure alterations in vessel diameter in health and disease. However, vessel contrast is often reduced due to stray light caused by illumination of lash, lid, or pupil margin. We introduce and validate a new setup for DVA, that comprises a novel 12-fold segmented LED-based illuminating unit and a fundus camera.

Methods : We studied 15 young volunteers (8m, 7f, 24.7±1.1 years) for two main reasons. First, to investigate the repeatability of the novel LED-equipped setup. Second, to compare the new setup with the Gold standard. In either case, the relative vaso-dilatation value was determined. We measured four primary vessels: one superior temporal artery and vein (STa/STv), and one inferior temporal artery and vein (ITa/ITv). All subjects were free of ocular and systemic diseases. The segmented LED-based illuminating unit was connected to a mydriatic fundus camera (Visucam, Carl Zeiss Meditec AG). We followed the DVA standard protocol. The beam geometry was annular (all segments on). Each volunteer was measured three times. One measurement with the Gold standard and two with the new setup, in a random order, and having a pause time of ten minutes between two measurements. Repeatability and comparison of the two setups were analyzed using the Bland-Altmann method. To value the differences among the group means we performed the t-test. For groups that did not meet the normality assumption we employed the Mann-Whitney U test.

Results : The repeatability analysis showed the following mean differences (MD), Limits of Agreement (LoA) and p-values ($p>0.05$ means no significant difference) with n=15 for every type of vessel. STa: MD=0.89%, LoA=-6.05%/+7.83, p=0.424. ITa: MD=-1.51%, LoA=-5.04%/+2.02, p=0.014. STv: MD=-0.36%, LoA=-3.04%/+2.32, p=0.360. ITv: MD=-1.29%, LoA=-9.33%/+6.75, p=0.055. Comparing the two different setups the p-values were 0.315 (STa), 0.415 (ITa), 0.005 (STv), and 0.203 (ITv).

Conclusions : We successfully performed a new approach of Dynamic Vessel Analysis using a LED-based illuminating system. Validation was realized in comparison to the Gold standard. The agreement between the two setups was predominantly good. Two times, but for different vessel segments, we could find statistically significant differences. However, most results show no significant differences between our new setup and the Gold standard.

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