Phenotyping the retinal microcirculation by use of impedance cardiography: association between early retinal alterations and hemodynamic profile

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Objective

Ratio of the caliber of retinal arterioles to venules (arteriovenous ratio, AVR) has been used as an easy and widely applied index of early-stage hypertensive retinopathy, with several multitudinal studies validating its prognostic value in terms of cardiovascular morbidity and mortality. Hypertensive patients exhibit diverse cardiovascular abnormalities and impedance cardiography has been proposed as a valuable tool for the stratification of patients according to their hemodynamic profile. The aim of the present study was to investigate whether any association exists between retinal AVR and hemodynamic parameters assessed with cardiography impedance, in a population lacking the complications of sustained hypertension.

Design and Method

We studied consecutive subjects attending the Hypertension Unit of our Department. Only individuals free from any known disease and under no medication, who reported normal blood pressure (BP) measurements within the previous year, were included. Retinal photography was used to obtain retinal microvascular diameter measurements (central retinal arterial and venular equivalent, CRAE and CRVE, respectively), and subsequently AVR, using specifically designed, semi-automated software (Figure 1). All participants underwent impedance cardiography for the measurement of hemodynamic parameters, including stroke volume (SV), cardiac output (CO), thoracic fluid content (TFC), and systemic vascular resistance (SVR).

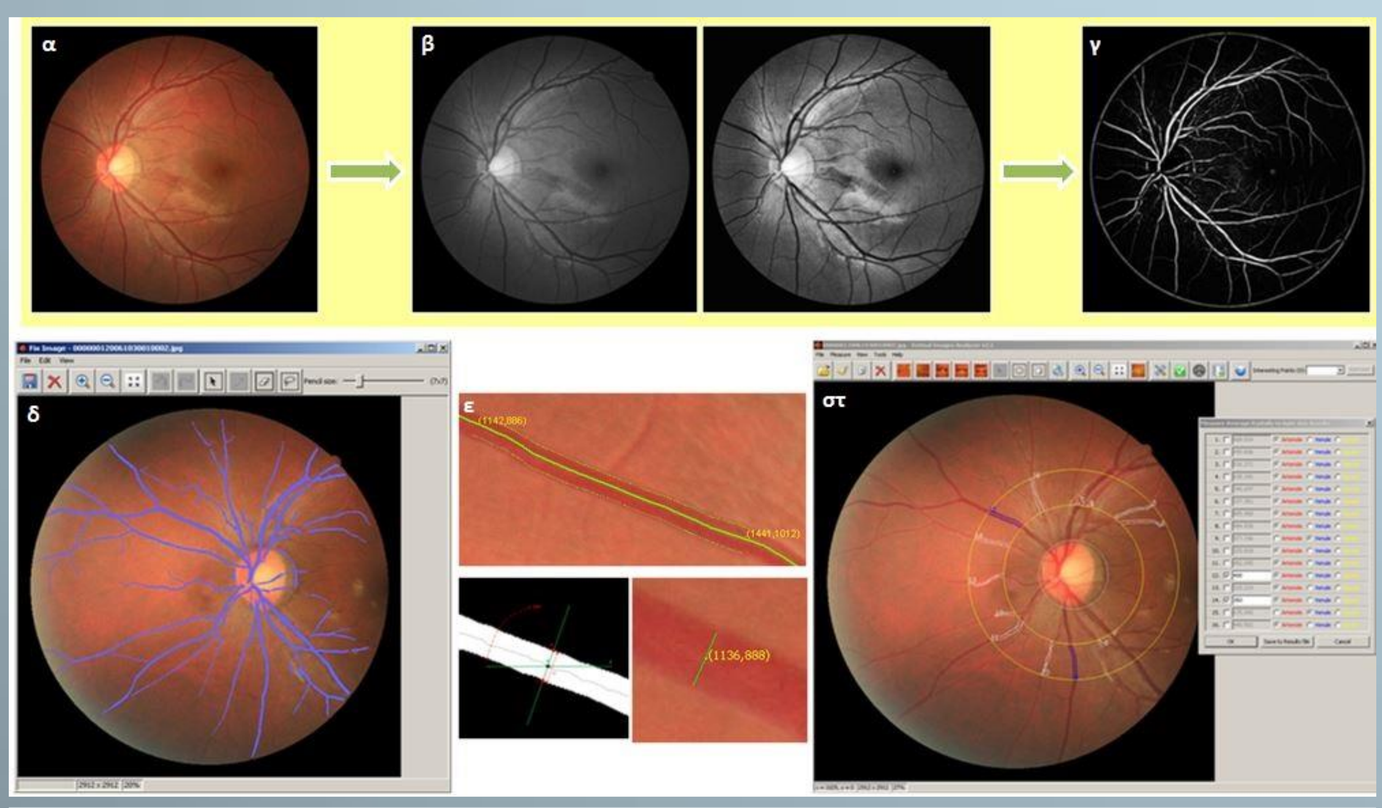

Figure 1. Depiction of the retinal imaging analysis software, which was used in the present study.

Results

A total of 46 otherwise healthy individuals apart from increased BP were included, 34 male and 12 female aged 43.8±9.8 years, with a mean systolic/diastolic BP of 143.8±18.6/90.4±11.2 mmHg. Baseline characteristics of the study population are depicted in Table 1.

Table 1. Baseline characteristics of the study population

	Total population (n=46)
Age (years)	43.8±9.8
Male gender, n (%)	34 (74)
BMI (kg/m²)	27.5±4.7
SBP/DBP (mmHg)	143.8±18.6/90.4±11.2
Heart rate (/min)	73.9±14.6
Hypertension (%)	71.7
AVR	0.74±0.11
SV (ml)	97.1±28.5
CO (l/min)	7.0±1.7
TFC (l/kOhm)	32.3±4.7
SVR (dyn•s•cm^{-5})	97.1±28.5

BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; SV: stroke volume, CO: cardiac output; TFC: thoracic fluid content; SVR: systemic vascular resistance.

In particular, mean AVR was 0.74±0.11. Mean SV was 97.1±28.5 ml, mean CO was 7.0±1.7 l/min, mean TFC was 32.3±4.7 l/kOhm, and mean SVR was 1171.9±312.2 dyn•s•cm-5. Of these parameters, only SVR significantly correlated with AVR (r=0.410, p=0.012). SVR was identified as the only independent predictor of AVR after adjustment for other parameters (age, sex, body mass index and BP) in the multiple regression model (p=0.012), as depicted in Table 2.

Conclusions

Using non-invasive, easily applicable, low-cost technology, the present study demonstrates for the first time an inverse association between SVR and AVR in a meticulously selected population free from the effects of long-standing hypertension. Whether increased SVR is the cause or consequence of decreased AVR warrants future studies.

Table 2. Independent predictors of AVR, after multiple linear regression analysis
Dependent variable: AVR,
adjusted r^2: 0.206, r^2: 0.316,p=0.025

	Unst. C (B)	St. C (Beta)	P value
Age (years)	0.000	0.002	0.823
BMI (mg/Kg²)	-0.006	0.004	0.099
Office DBP (mmHg)	-0.002	0.002	0.194
SEX	0.045	0.038	0.254
SVR (dyn•s•cm^{-5})	0.000	0.000	0.012

AVR: Arteriovenus ratio, BMI: Body mass index, DBP: Diastolic blood pressure, SVR: systemic vascular resistance