



ORIGINAL ARTICLE

Comparison of subjective and objective methods to determine the retinal arterio-venous ratio using fundus photography



Rebekka Heitmar^{a,*}, Angelos A. Kalitzeos^a, Sunni R. Patel^{b,c},
Diana Prabhu-Das^a, Robert P. Cubbidge^a

^a Aston University, School of Life and Health Sciences, Birmingham, UK

^b Topcon Corporation USA, NJ, USA

^c Toronto Western Hospital, Department of Ophthalmology and Vision Sciences, Toronto, Canada

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Arterio-venous ratio;
Central retinal artery equivalent;
Central retinal vein equivalent;
Reproducibility;
Semi-automated analysis;
Visual grading

Abstract

Purpose: To assess the inter and intra observer variability of subjective grading of the retinal arterio-venous ratio (AVR) using a visual grading and to compare the subjectively derived grades to an objective method using a semi-automated computer program.

Methods: Following intraocular pressure and blood pressure measurements all subjects underwent dilated fundus photography. 86 monochromatic retinal images with the optic nerve head centred (52 healthy volunteers) were obtained using a Zeiss FF450+ fundus camera. Arterio-venous ratios (AVR), central retinal artery equivalent (CRAE) and central retinal vein equivalent (CRVE) were calculated on three separate occasions by one single observer semi-automatically using the software VesselMap (ImedosSystems, Jena, Germany). Following the automated grading, three examiners graded the AVR visually on three separate occasions in order to assess their agreement.

Results: Reproducibility of the semi-automatic parameters was excellent (ICCs: 0.97 (CRAE); 0.985 (CRVE) and 0.952 (AVR)). However, visual grading of AVR showed inter grader differences as well as discrepancies between subjectively derived and objectively calculated AVR (all $p < 0.000001$).

Conclusion: Grader education and experience leads to inter-grader differences but more importantly, subjective grading is not capable to pick up subtle differences across healthy individuals and does not represent true AVR when compared with an objective assessment method. Technology advancements mean we no longer rely on ophthalmoscopic evaluation but can capture

* Corresponding author at: Aston University, School of Life and Health Sciences, Aston Triangle, B4 7ET Birmingham, UK.

Tel.: +44 0121 204 3853.

E-mail address: R.Heitmar1@aston.ac.uk (R. Heitmar).

and store fundus images with retinal cameras, enabling us to measure vessel calibre more accurately compared to visual estimation; hence it should be integrated in optometric practise for improved accuracy and reliability of clinical assessments of retinal vessel calibres.

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PALABRAS CLAVE

Diámetro de los vasos de la retina;
Ratio arterio-venoso;
Equivalente de la arteria retiniana central;
Equivalente de la vena retiniana central;
Reproducibilidad;
Análisis semi-automatizado;
Graduación visual

Comparación de métodos subjetivos y objetivos para determinar el ratio arterio-venoso de la retina, utilizando la fotografía del fondo del ojo

Resumen

Objetivo: Evaluar la variabilidad de la graduación subjetiva del ratio arterio-venoso de la retina entre distintos observadores, utilizando la graduación visual, y comparar los grados subjetivamente calculados con un método objetivo que utiliza un programa informático semi-automatizado.

Métodos: Tras medir la presión intraocular y la presión sanguínea, se realizó una fotografía del fondo del ojo dilatado a todos los sujetos. Se obtuvieron 86 imágenes monocromáticas de la retina con la cabeza del nervio óptico centrada (52 voluntarios sanos), utilizando una cámara Zeiss FF450+ para el fondo del ojo. Se calcularon los ratios arterio-venosos (AVR), el equivalente de la arteria retiniana central (CRAE) y el equivalente de la vena retiniana central (CRVE) en tres ocasiones diferentes y mediante un único observador, utilizando el software VesselMap (ImedosSystems, Jena, Alemania). Tras la graduación automática, tres examinadores graduaron los AVR visualmente en tres ocasiones diferentes, a fin de valorar la concordancia.

Resultados: La reproducibilidad de los parámetros semi-automáticos fue excelente (ICCs: 0,97 (CRAE); 0,985 (CRVE) y 0,952 (AVR)). Sin embargo, la graduación visual del AVR mostró diferencias entre los distintos graduadores, así como discrepancias entre los AVR subjetiva y objetivamente calculados (todas las comparaciones: $p < 0,000001$).

Conclusión: La formación y experiencia del graduador origina diferencias entre los diferentes graduadores pero lo más relevante es que la graduación subjetiva no es capaz de recoger las diferencias sutiles entre los sujetos sanos, y no representa el AVR real cuando se compara con un método de valoración objetivo. Los avances tecnológicos implican que no debemos seguir dependiendo de la valoración oftalmoscópica, sino captar y almacenar las imágenes del fondo del ojo tomadas con cámaras retinianas, lo que nos permite medir más precisamente el calibre de los vasos en comparación a la estimación visual; por tanto, dichos avances deberían integrarse en la práctica optométrica para mejorar la precisión y fiabilidad de las valoraciones clínicas de los calibres de los vasos de la retina.

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Introduction

Assessing retinal vessel appearance including relative diameters is part of a standard ocular examination. Retinal vessel diameters have been shown to be valuable markers of systemic and ocular vascular complications in a range of pathologies including diabetes,¹⁻³ cardiovascular disease⁴⁻⁶ and cerebrovascular complications.^{7,8} Despite the availability of a wide range of semi-automatic programs which can measure retinal arteriolar and venular diameters in order to calculate arterio-venous ratios (AVR), most optometrists still make a visual assessment.

Changes due to vascular abnormalities and those related to age are often subtle and can be overlooked when using visual grading systems. Most optometric practices are equipped with a digital fundus camera, typically used for diabetic retinopathy screening. Some of these software

packages come with further image analyses options offering the possibility to measure retinal vessel diameters.

Visual grading systems in general exhibit poor reproducibility, low sensitivity and specificity as well as being highly dependent upon observer experience.⁹ Changing observers/clinicians can lead to bias in analysing progression data, especially if observer variability is dependent on experience. Visual grading of arterio-venous ratio is almost binary in nature as it reflects a comparison of the relative diameter of retinal arteries to those of retinal veins. There is a wide variety of literature and educational material used to teach clinicians and it is apparent that there is not only a lack of standardisation with respect to the measurement location but also in the numerical value of the ratio reflecting the "normal/healthy" diameter relationship.¹⁰⁻¹² While some sources recommend comparison between vessels beyond the first bifurcation¹⁰ others advise on the use

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