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ADAPTIVE OPTICS OPHTHALMOSCOPY IN DIABETIC RETINOPATHY

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ABSTRACT

Diabetic retinopathy is the leading cause of visual loss and blindness in working-age adults and represents the most common microvascular complication of diabetes mellitus.

The current research assesses the retinal arterioles status in healthy volunteers and diabetic patients, in order to detect early retinal changes by using adaptive optics ophthalmoscopy (AOO), a cutting edge, non-invasive imaging technique. Our patients were evaluated between 2021-2022 in the Retina Clinic Bucharest, Romania. All of them underwent a complete ophthalmologic examination. By using rtx1™ adaptive optics retinal camera (Imagine Eyes, Orsay, France) together with the manufacturer's software (AO detect artery, Imagine Eyes, France), several vascular parameters of the retinal arteriole were calculated, including wall to lumen ratio (WLR), vessel diameter (VD), lumen diameter (LD), mean wall thickness (WT) and cross-sectional area of the vascular wall (WCSA).

All five studied vascular parameters were found to have higher values in diabetic patients, when compared to healthy volunteers. The differences were statistically significant for WT, WLR and WCSA (p values under 0.05).

Adaptive optics ophthalmoscopy represents a cutting-edge technique, opening a new era in the medical retina field. It provides useful data regarding the retinal vascular status, in a non-invasive manner, being a promising tool in the diagnosis, staging and follow-up of diabetic retinal disease.

Keywords: adaptive optics ophthalmoscopy, diabetic retinopathy

Introduction

Diabetic retinopathy (DR) is the one of the leading causes of visual loss and blindness worldwide and represents the most common microvascular complication of diabetes mellitus (1). Lesions such as exudates, microaneurisms, hemorrhages, macular edema and neovascularization, are considered to be biomarkers of the DR status, being assessed during the clinical examination (2).

Retinal vessels geometry, including measurements of vessel branching angles, branching complexity, tortuosity, length-to-diameter ratio and fractals comprehend another group of retinal vessel-linked biomarkers (2). For example, a decreased fractal dimension has been shown to be associated with diabetic retinopathy (3). Furthermore, several studies have proven that changes in retinal vascular caliber are among the first to appear in diabetic patients. Given all these reasons, retinal vascular parameters have become interesting biomarkers for DR, of increasingly value (4).

The current study assesses the retinal microvasculature of healthy volunteers and diabetic patients (with nonproliferative or proliferative diabetic retinopathy), by using adaptive optics ophthalmoscopy (AOO). This cutting edge, non-invasive imaging technique

allows the calculation of several vascular parameters, which were taken into consideration in the comparative analysis between the two groups.

Methods

The current research assesses comparatively the retinal arterioles status of healthy volunteers and diabetic patients. Two study groups including ten patients each (healthy controls and diabetic patients with nonproliferative or proliferative diabetic retinopathy) were evaluated between 2021-2022 in the Retina Clinic Bucharest, Romania. All participants were adult caucasians over 18 years old, with small refractive errors (less than 3 spherical or cylindrical diopters), without significant ocular pathology except for diabetic retinopathy and without significant medical history except for diabetis mellitus. Moreover, any disease-related interventions (retinal laser, vitrectomy or intravitreal drug administration) were performed more than 6 months before the inclusion in the current study.

All participants underwent a complete ophthalmologic examination, including medical history, best corrected visual acuity (BCVA) and intraocular pressure (IOP) measurements and slit lamp examination of the anterior and posterior segments.

By using rtx1™ adaptive optics retinal camera (Imagine Eyes, Orsay, France) together with the manufacturer's software (AO detect artery, Imagine Eyes, France), several vascular parameters of the retinal arterioles were calculated, namely vessel diameter (VD), lumen diameter (LD), mean wall thickness (WT), wall to lumen ratio (WLR) and cross-sectional area of the vascular wall (WCSA) (Figure 1). Optical biometry (IOL Master 700, Zeiss) was used in order to measure the axial length, due to the fact that the manufacturer's software needs this input in order to adjust the data values.

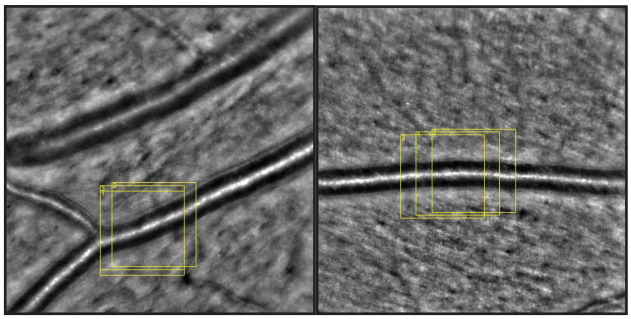


Figure 1. Adaptive optics ophthalmoscopy (superior/ inferior branch of central retinal artery). A) Healthy control. B) Diabetic patient. Using the manufacturer's software, the parameters were calculated from the three selected areas of interest, for each time landmark (100 µm width and height each).

Data analysis was performed using Microsoft Excel software. The results were expressed as mean ± standard deviation. Given the normal distribution of the data, the independent samples t-test was suitable to evaluate the statistical significance (considered for p values under 0.05).

Results

A total number of 10 diabetic patients (6 males and 4 females, mean age 49.10 ± 7.27 years) and 10 healthy volunteers (5 males and 5 females, mean age 47 ± 10.81 years) were included in the study. Regarding the diabetic patients study group, 3 patients suffer of type I and 7 patients of type II of diabetes mellitus, having a mean duration of the disease of 14.1 ± 9.25 years. Half of the diabetic patients were insulin-dependent at the moment of inclusion. As expected, the best corrected visual acuity (BCVA) was significantly higher in the control goup than in the diabetic group (p=0.0033) (Table 1).

Table 1. Characteristics of the control and diabetic groups (expressed as mean ± standard deviation)

	Control group	Dibetic group
Number of patients	10	10
Sex (male/female)	5/5	6/4
Age (years)	47 ± 10.81	49.10 ± 7.27
Best corrected visual acuity (decimal)	1	0.69 ± 0.26
Diabetes duration (years)	0	14.1 ± 9.25
Axial length (mm)	24.29 ± 0.98	23.63 ± 0.78

After axial length adjustment, all five vascular parameters were found to have higher values in diabetic patients, when compared to healthy volunteers, while the differences were statistically significant for wall thickness (p=0.0001), wall-to-lumen ratio (p=0.0073) and cross-sectional area of the vascular wall (p=0.0136). There were no significant differences between the groups concerning the values of vessel diameter (p=0.20) and lumen diameter (p=0.63) (Table 2).

Table 2. Vascular parameters measured using adaptive optics ophthalmoscopy (expressed as mean ± standard deviation)

Vascular parameters	Control group	Diabetic group
Vessel diameter (m)	88.05 ± 16.93	101.32 ± 24.29
Lumen diameter (m)	69.99 ± 15.22	74.46 ± 21.54
Wall thickness (m)	9.01 ± 1.29	13.41 ± 2.28
Wall to lumen ratio	0.26 ± 0.03	0.38 ± 0.10
Wall cross sectional area (m2)	2279.33 ± 700.44	3811.77 ± 1473.29

Discussions

Diabetic retinopathy is the leading cause of visual loss and blindness in working-age adults. When associated, a poor glycemic control, uncontrolled hypertension, dyslipidemia, nephropathy, male gender and obesity are all unfavourable prognostic factors. Early detection, regular medical follow-up and timely intervention are of great impact on the evolution of the disease (1).

In the big run, the retinal vascular parameters calculated with the help of adaptive optics retinal camera are becoming valuable players in the field of diabetic retinopathy biomarkers (2).

Conclusions

Regarding to the retinal vascular structure, together with the retinal vessel lesions and their geometry, the retinal vascular parameters are also considered to be valuable biomarkers for DR (2).

The current study proves once more the appearance of structural alterations seen in retinal arterioles of diabetic patients, mirrorred by WT, WLR and WCSA parameters. An increased WLR in patients with diabetic retinopathy has been reported in previous studies describing arteriolar remodeling (5, 6). The process itself may appear due to muscle hypertrophy and fibrosis and is best reflected by WLR (7, 8). Furthermore, WLR is considered to significantly correlate with the severity of diabetic retinopathy (9). The study groups didn't include subjects with undercompensated arterial hypertension, with other vascular disorders or which underwent any disease-related intervention (laser treatments, vitrctomies, intravitreal drug injections) more than 6 months before the inclusion, to avoid possible bias.

To conclude with, adaptive optics ophthalmoscopy represents a cutting-edge technique, opening a new era in the medical retina field. It provides useful data regarding the retinal vasculature status, being a promising tool for the diagnosis, staging and follow-up of diabetic retinal disease in a non-invasive manner.

References

1. Shukla UV, Tripathy K. Diabetic Retinopathy. StatPearls. Treasure Island (FL): StatPearls Publishing Copyright © 2022, StatPearls Publishing LLC.; 2022.
2. Trivedi A, Desbiens J, Gross R, Gupta S, Dodhia R, Ferres JL. Retinal Microvasculature as Biomarker for Diabetes and Cardiovascular Diseases. arXiv preprint arXiv:210713157. 2021.
3. Huang F, Dashtbozorg B, Zhang J, Bekkers E, Abbasi-Sureshjani S, Berendschot TTJM, et al. Reliability of Using Retinal Vascular Fractal Dimension as a Biomarker in the Diabetic Retinopathy Detection. J Ophthalmol. 2016;2016.
4. Ikram MK, Cheung CY, Lorenzi M, Klein R, Jones TLZ, Wong TY, et al. Retinal Vascular Caliber as a Biomarker for Diabetes Microvascular Complications. Diabetes Care. 2013;36(3):750-9.
5. Zaleska-Zmijewska A, Wawrzyniak ZM, Dabrowska A, Szaflik JP. Adaptive Optics (rtx1) High-Resolution Imaging of Photoreceptors and Retinal Arteries in Patients with Diabetic Retinopathy. J Diabetes Res. 2019;2019.

6. Baltă F, Cristescu IE, Mirescu AE, Baltă G, Zemba M, Tofolean IT. Investigation of Retinal Microcirculation in Diabetic Patients Using Adaptive Optics Ophthalmoscopy and Optical Coherence Angiography. J Diabetes Res. 2022;2022:1516668.
7. Ding J, Cheung CY, Ikram MK, Zheng YF, Cheng CY, Lamoureux EL, et al. Early retinal arteriolar changes and peripheral neuropathy in diabetes. Diabetes Care. 2012;35(5):1098-104.
8. Rizzoni D, Agabiti Rosei C, De Ciuceis C, Semeraro F, Rizzoni M, Docchio F. New Methods to Study the Microcirculation. Am J Hypertens. 2018;31(3):265-73.
9. Burns SA, Elsner AE, Sapoznik KA, Warner RL, Gast TJ. Adaptive optics imaging of the human retina. Prog Retin Eye Res. 2019;68:1-30.