Blood flow parameters in temporal short posterior ciliary arteries in myopic patients

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ABSTRACT

Introduction: Myopia is the most common refractive defect. Enlargement of the defect is the result of lengthening of the eyeball. This leads to the development of degenerative changes in the retina and choroid of the eye due to the stretching of tissues. The aim of our study was assessment of blood flow parameters in temporal short posterior ciliary arteries depending on the character of degenerative lesions found in the ocular fundus in myopic people.
Material and Methods: The study involved 70 myopic people (17 men and 53 women) aged 18-79 years (44.9 ± 18.3) with eyeball length of 22.61mm-33.36mm (27.9±5.37). Degenerative lesions in the ocular fundus were thoroughly examined in each study participant. The patients were divided into 4 groups, depending on the nature and extent of the lesions. Blood flow parameters were assessed (maximum velocity Vmax, minimum velocity Vmin, mean velocity Vm, resistive index RI and pulsatility index PI) in short posterior ciliary arteries located on temporal side of the optic nerve, by color Doppler imaging (CDI).
Results: The progression of degenerative lesions in the ocular fundus was associated with slightly varying correlations of blood flow through the cilliary vessels depending on temporal locations. In the temporal short posterior ciliary vessels, blood flow was decreased statistically significantly (reduced Vmax, Vmin, Vm), both in the right and left eyes. The PI and RI changes were insignificant.
Conclusions: Worsening of blood flow through the temporal short posterior ciliary arteries was associated with deterioration of degenerative lesions in the ocular fundus in myopic patients.
Key words: degenerative lesions, temporal short posterior ciliary arteries, CD-imaging

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INTRODUCTION

Myopia is a common refractive error that affects ever more people [1, 2]. Genetic factors related to lifestyle (many hours spent at the computer, paperwork) predispose to the development of this defect [3-7]. Enlargement of the error is the result of lengthening of the axial length of the eyeball. As a result, these changes contribute to the development of degenerative changes in the retina [8]. The most commonly, myopic crescent degeneration is encountered, which is located at the temporal edge of the optic disc. However, the literature is not clear which factors directly trigger different pathological processes in case of myopia [9, 10].

Because most of degeneration is located on the temporal side of the optic nerve the aim of our study was to assess blood flow parameters in temporal short posterior ciliary arteries (tSPCA) depending on the character of degenerative lesions found in the ocular fundus in myopic people.

MATERIAL AND METHODS

Seventy people with myopia, including 53 women (75.7%) and 17 men (24.3%) aged 18 - 79 years (mean 44.9±18.3), patients of Ophthalmology Department and Outpatient Clinic at University Hospital in Bialystok, were recruited to the study. Myopia was diagnosed on the basis of eye length measurement by ultrasound imaging using **E-Z Scan AB 5500**+, and taking into consideration vision defect confirmed by an autorefractometer Topcon KR 9800 after paralysis of accommodation (cycloplegia) with 1% Tropicamide. All the study participants were generally healthy. The study was approved by the Bioethics Committee. Four groups of patients were distinguished, depending on the character and extent of degenerative lesions observed in the ocular fundus. Group I consisted of 32 patients (23 women and 9 men; 45.7%), aged 21-67 years (34.5±15.2), without evident degenerative lesions in the ocular fundus. Twenty-eight patients in that group (87.5%) had visual acuity equal 1.0 in the best spectacle correction. The mean eye length in this group was 24.7±1.09 mm. Group II was made up by 20 patients (28.6%), 17 women and 3 men at the age of 18-79 years (35.7±16.3), with chorioretinal atrophy at the optic disc, called myopic crescent. The mean eye length in this group was 26.24±1.44 mm, and visual acuity in the correction applied was 0.9±0.17. Group III contained 8 patients (11.4%), 6 women and 2 men aged 29-65 (49.5±12.35), who apart from myopic crescent also had rarefied retinal structure. The mean eye length in this group was 26.97±2.14 mm, and visual acuity 0.39±0.3 in the optimum correction. Patients in group IV additionally had extensive chorioretinal atrophies in the posterior pole. This group consisted of 10 patients (14.3%), 7 women and 3 men aged 18-73 (52.9±16.43), with the mean eye length of 28.75 mm and mean visual acuity of 0.19±0.3. In all study patients, blood flow parameters in right and left eyes were assessed (maximum velocity Vmax, minimum velocity Vmin, mean velocity Vm, resistive index RI and pulsatility index PI) in the short posterior ciliary arteries of the temporal optic disc, by color Doppler imaging in projection B using Toshiba Aplio SSA 770A with a linear probe of 14.0 MHz. Patients were examined in the supine position. A layer of gel was placed on the closed eyelids to facilitate ultrasonic conduction. Blood flow in short posterior ciliary arteries was assessed when they were found in the posterior region of the ocular wall, on the temporal side from the hypoechogenic area corresponding to the optic nerve. In all measurements, the angle between the Doppler beam and vessel axis ranged from 0˚ to 20˚. All the measurements were performed three times and the values were averaged.

Variance analysis and Spearman correlation coefficient were chosen for statistical assessment, where the values above 0.5 were considered high correlation. All statistical hypotheses were verified at the level of significance $p<0.05$. Statistica 6.0 (StatSoft) was used for calculations.

RESULTS

The study involved 70 myopic people (17 men and 53 women) aged 18-79 years (mean 44.9 ± 18.3) with eye length of 22.61mm-33.36mm (27.9±5.37). The eye length shorter than 26 mm was found in 31 women and 7 men, longer than 28 mm in 7 women and 4 men. The eye length ranging between 26 mm and 28 mm was observed in 15 women and 6 men. Blood flow parameters in the temporal vessels were statistically significantly correlated with the appearance of the ocular fundus. In these vessels, deterioration in the parameters was parallel to the exacerbation of degenerative lesions in the retina and choroid of the eye. The increase in the degenerative lesions was accompanied by a statistically significant decrease in Vmax, both on the right and left side. The Spearman correlation coefficient was -0.27 in the right eye ($p=0.034$) and -0.34 in the left eye ($p=0.05$). The correlations were statistically significant.

Similar correlations were also observed for Vmin. A reduction in Vmin caused a statistically significant increase in the degenerative lesions both in the right and left eyes. The Spearman correlation coefficient was -0.36 in the right eye ($p=0.003$) and -0.44 in the left eye ($p=0.000$). The lesions in the right eyes, like in the case of Vmax, were slightly

less pronounced as compared to those in the left eyes. However, the differences were statistically insignificant. Changes observed in the resistive index (RI) and pulsatility index (PI) did not show any statistically significant values. Together with the increase in the degenerative lesions in the retina and choroid, RI and PI were found to increase in the temporal SPCA both in the right and left eyes

A detailed statistical analysis of the changes in blood flow parameters in the temporal short posterior artery depending on degenerative lesions is presented in Table I.

Table I. Changes in blood flow parameters in temporal SPCA depending on degenerative lesions in the ocular fundus - statistical assessment, SC - Spearman correlation coefficient, P- correlation significance). Statistically significant changes are marked in bold.

		SC		P	
		RE	LE	RE	LE
tSPCA	Vmax	-0.27	-0.34	0.034	0.007
	Vmin	-0.36	-0.44	0.003	0.000
	Vm	-0.31	-0.42	0.013	0.001
	PI	0.16	0.17	0.198	0.191
	RI	0.19	0.14	0.139	0.285

In the right temporal SPCA without degenerative lesions, the mean value of Vmax was 13.57 cm/s, whereas in patients with chorioretinal atrophy around the optic disc the mean blood flow was 12.13 cm/s. Patients with chorioretinal atrophy and rarefied retina presented further exacerbation of blood flow and the mean value of Vmax amounting to 10.96 cm/s. In patients who additionally had chorioretinal atrophy in the posterior pole, blood flow velocity was even lower (10.88 cm/s on average). These changes were not statistically significant (p=0.188). Similar correlations, although statistically significant (p=0.037) were observed on the left side. The Vmin of blood flow through temporal SPCA showed similar changes in the right eye, the mean Vmin was 4.56 cm/s in subjects without degenerative lesions in the eye fundus.

In patients with myopic crescent, the mean Vmin was 4.13 cm/s. However, in patients with additionally observed rarefied retina, Vmin was only 2.76 cm/s and showed a further decrease along with exacerbation of degenerative lesions in the eye fundus, so that in myopic patients who had extensive chorioretinal atrophy in the posterior pole it was only 2.54cm/s (p=0.071). Like in the case of Vmax, also for Vmin the correlations observed in the temporal SPCA in the left eyes were analogical (p =0.004). Changes observed in the PI and RI, both in the right and left eyes, were not statistically significant. Detailed changes in blood flow parameters in the temporal SPSA in the right and left eyes are presented in Tables II and III.

Table II. Blood flow in the temporal SPCA in the right eyes in the respective study groups (cm/sec). SD - standard deviation, p - level of statistical significance.

		Right eye fundus				
		I	II	III	IV	p
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
tSPCA	Vmax	13.57 ± 3.91	12.13 ± 3.23	10.96 ± 1.87	10.88 ± 5.13	0.188
	Vmin	4.56 ± 2.62	4.13 ± 1.72	2.76 ± 1.97	2.54 ± 0.50	0.071
	Vm	8.29 ± 3.03	7.21 ± 2.25	6.18 ± 1.45	5.94±2.41	0.084
	PI	1.15 ± 0.42	1.10 ± 0.23	1.43 ± 0.70	1.33 ± 0.26	0.239
	RI	0.66 ± 0.12	0.65 ± 0.08	0.75 ± 0.15	0.73 ± 0.09	0.144

Table III. Blood flow in the temporal SPCA in the left eyes in the respective study groups (cm/sec). SD - standard deviation, p - level of statistical significance.

		Left eye fundus				
		I	II	III	IV	p
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
tSPCA	Vmax	13.85 ± 4.12	12.07 ± 2.61	10.76 ± 2.14	10.89 ± 3.51	0.037
	Vmin	4.73 ± 1.91	4.32 ± 1.03	3.59 ± 0.74	2.82 ± 1.33	0.004
	Vm	8.51 ± 2.55	7.32 ± 1.50	6.72 ± 1.07	6.05 ± 1.85	0.006
	PI	1.09 ± 0.37	1.07 ± 0.23	1.07 ± 0.27	1.33 ± 0.37	0.137
	RI	0.65 ± 0.11	0.63 ± 0.07	0.66 ± 0.09	0.72 ± 0.11	0.115

DISCUSSION

Long and short posterior ciliary arteries are the fundamental source of choroidal vascularization. The ciliary vasculature is individually varied. The ciliary vessels usually begin with two main trunks: one lateral and the other central. They branch at an acute angle into smaller derivative vessels which vary in course. Around the entrance of the optic nerve they penetrate the sclera and reach the choroid as the short posterior ciliary arteries [11]. For that reason, Doppler imaging of ciliary vessels is much more difficult than imaging of the ocular artery or central retinal artery, and requires greater experience.

In our study, blood flow through ciliary vessels deteriorated along with advanced degenerative lesions in the eye fundus. The maximum and minimum velocities in short posterior ciliary arteries became reduced on the temporal side of the optic nerve. We also found some differences between the right and left eyes.

Similarly, Akyol and Dymitrowa performing separate studies concerning blood flow in the short posterior ciliary arteries noted that the increasing axial eye length and the development of degenerative lesions in the ocular fundus were associated with reduced maximum and minimum velocity of blood flow and a rise in the resistive index [8, 12].

Also, in animal studies, Fitzgerald and Reiner and their colleagues observed thinning of the choroidal structure and blood flow deterioration, which is consistent with our current results [13, 14].

Research conducted by Giuffre [15] seems to support our findings of more frequent degenerative lesions on the temporal side of the optic disc (myopic crescent) and more substantial worsening of blood flow through the temporal ciliary vessels. As previously mentioned, ciliary vessels form two vascular bundle on each side of the optic nerve (n. II). These terminal vessels supply the area that shows inadequate blood supply zone on its margin, called the aqueous humour. When blood flow in the ciliary vessels, both nasal and temporal, is reduced, which is manifested by a drop in Vmax and Vmin, the aqueous humour zone is at a higher risk of insufficient blood supply than the chorioretinal sectors. Giuffre, who undertook anatomical classification of the aqueous humour, distinguished 6 separate regions. Interestingly, in half of the cases, the aqueous humour covers mainly the temporal part of the optic disc and the adjacent choroid on the same side. Therefore, a drop in blood flow velocity in temporal location causes mainly insufficient blood supply in this sector and leads to the development of degenerative lesions on that side of the optic disc. We observed degenerative lesions on the nasal side of the optic disc only in very high myopia.

Concluding the current findings, the development of degenerative lesions in the ocular fundus is associated both with the elongation of the axial length of the eye, and with worsening of blood flow.

CONCLUSION

Worsening of blood flow through the temporal short posterior ciliary arteries was associated with deterioration of degenerative lesions in the ocular fundus in myopic patients.

Conflicts of interest

The authors declare no conflict of interest.

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