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XORİORETİNAL DİSTROFİYA İLƏ MÜŞAYİƏT OLUNAN PROQRESSİVLƏŞƏN MİOPİYA ZAMANI KSENOSKLEROPLASTİKANIN DOPPLEROMETRİK QİYMƏTLƏNDİRİLMƏSİ

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XÜLASƏ

Son dövrlərdə proqressivləşən miopiya zamanı xorioretinal distrofiyanın yayılma tezliyində artım müşahidə olunur. Ədəbiyyat məlumatlarında miopiya fonunda tor qişanın distrofiyası olan xəstələrdə hemodinamik dəyişikliklərin mexanizmi ətraflı araşdırılsa da, bu xəstəliyin konservativ müalicəsi hər zaman effektiv nəticə vermir. Prosesin proqressivləşməsini stabilləşdirən cərrahi üsullardan biri də ksenotransplantasiya üsuludur.
Məqsəd – ağır xorioretinal distrofiya ilə proqressivləşən miopiya zamanı göz arteriyası sistemindəki hemodinamik göstəricilərin dinamikası əsasında ksenoskleroplastikanın effektivliyini qiymətləndirmək.

Material və metodlar

Klinik tədqiqatlara proqressivləşən miopiya fonunda xorioretinal distrofiyası olan 46 xəstə (86 göz) cəlb olunmuşdur. Pasiyentlər iki qrupa bölünmüşdür: nəzarət qrupu – yalnız konservativ müalicə alan 10 nəfər (16 göz), əsas qrup isə ksenoskleroplastika əməliyyatı icra edilmiş 36 nəfər (70 göz). Tədqiqata daxil edilən xəstələrin yaşı 12-43 arası dəyişmiş, miopik refraksiya dərəcəsi isə (-) 9.0 D ilə (-) 22.0 D arasında olmuşdur. Standart oftalmoloji müayinələrlə yanaşı, Dopplerometrik müayinə ilə göz arteriyası, tor qişanın mərkəzi arteriyası və qısa arxa siliar arteriyalarda qan axınının xətti sürəti (QAXS) qiymətləndirilmişdir. Göstəricilərin müqayisəli təhlili 1 il ərzində – əsas qrupda ksenoskleroplastikadan əvvəl və sonra, nəzarət qrupunda isə konservativ terapiyadan əvvəl və sonra aparılmışdır.

Nəticələr

Xorioretinal distrofiya ilə müşaiyət olunan proqressivləşən miopiya zamanı gözün qan dövranının dinamik tədqiqi, ksenoskleroplastikadan sonra qan axını sürətinin orta hesabla 2 sm/san artmasını aşkar etmişdir ki, bu da görmə funksiyalarının stabilləşməsinə və yaxşılaşmasına zəmin yaradır. İnteqrasiya olunmuş ksenotransplantat ətraf toxumalarda yerli iltihabi reaksiya yaratmaqla hemodinamikanın güclənməsinə, nəticədə göz arteriyası sistemində qan axını sürətinin artmasına şərait yaratmışdır. Bu proses, öz növbəsində, tor qişa və görmə siniri səviyyəsində mikrosirkulyasiyanın əhəmiyyətli dərəcədə yaxşılaşması ilə nəticələnmişdir.

Yekun

Ağırlaşmış xorioretinal distrofiya ilə müşayiət olunan proqressivləşən miopiya zamanı ksenoskleroplastika tor qişanın distrofik dəyişikliklərini stabilləşdirən effektiv bir üsuldur. Bu zaman, göz arteriyası sistemində qan axını sürətinin Dopplerometrik müayinəsi icra edilən cərrahi müalicənin effektivliyini qiymətləndirməyə imkan verən obyektiv meyar hesab olunur.

Açar sözlər: *proqressivləşən miopiya, xorioretinal distrofiya, ksenoskleroplastika, qan axının sürəti, göz arteriyası, dopplerometrik müayinə*

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DOPPLEROGRAPHIC EVALUATION OF XENOSCLEROPLASTY IN PROGRESSIVE MYOPIA WITH CHORIORETINAL DYSTROPHY

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SUMMARY

In recent years, the proportion of chorioretinal dystrophy in progressive myopia has been growing. The literature provides a detailed analysis of the mechanism underlying hemodynamic impairment in patients with retinal dystrophy in myopia. The use of conservative treatment methods for progressive myopia is not always effective. Among the surgical interventions aimed at stabilizing the progression of myopia, the xenotransplantation method is also used.

Purpose – to evaluate the efficacy of xenoscleroplasty in progressive myopia complicated by chorioretinal dystrophy using the method of dynamic assessment of hemodynamics in the ophthalmic artery basin.

Material and methods

Clinical studies were conducted in two groups of patients presenting with progressive myopia complicated by chorioretinal dystrophy: a control group consisting of 10 patients (16 eyes) who received conservative treatment methods only, and a study group comprising 36 patients (70 eyes) who underwent xenoscleroplasty. Myopic refraction ranged from (-) 9.0 D to (-) 22.0 D, and patient age ranged from 12 to 43 years. Along with standard ophthalmological examination, linear blood flow velocity (BFV) in the ophthalmic artery, central retinal artery, and posterior ciliary arteries was evaluated over a one-year period using Doppler ultrasonography. These measurements were taken before and after xenoscleroplasty in the study group, and before and after conservative therapy in the control group.

Results

Dynamic assessment of hemodynamics in the ophthalmic artery basin in progressive myopia with chorioretinal dystrophy revealed an increase in BFV after xenoscleroplasty by an average of 2 cm/s, which could contribute to the improvement of ocular functions. The implanted xenograft induced a reactive inflammatory response accompanied by enhanced hemodynamics around the graft, thereby accelerating BFV in the ophthalmic artery basin. This, in turn, led to improved microcirculation at the level of the retina and optic nerve.

Conclusion

Xenoscleroplasty in progressive myopia complicated by chorioretinal dystrophy is an effective method for stabilizing retinal dystrophic lesions. Furthermore, Dopplerographic evaluation of BFV in the ophthalmic artery basins serves as an objective method for assessing the outcomes of the surgical treatment performed.

Key words: *progressive myopia, chorioretinal dystrophy, xenoscleroplasty, blood flow velocity, ophthalmic artery, Dopplerography*

Myopia continues to be one of the most prevalent ocular diseases worldwide and the most frequent cause of vision impairment. According to the World Health Organization, the number of individuals suffering from myopia in developed countries varies from 10% to 90%. While more than 10% of the population in Russia is nearsighted, this figure exceeds 25% in the US and Europe, and reaches up to 80% in Asian countries [1].

Nearsightedness can be accompanied by retinal detachment and myopic maculopathy, which are leading causes of disability in the young, working-age population [2]. When accounting for all age groups, myopia constitutes 18.0% of the overall structure of visual disability, ranking third [3].

Due to the elongation of the anteroposterior diameter of the eye in myopic patients, retinal dystrophy occurs as a result of retinal pigment epithelium thinning and choriocapillaris atrophy. Additionally, cracks develop in Bruch's membrane, through which neovascular vessels from the choroid grow beneath the pigment epithelium and neuroepithelium, subsequently leading to exudative-hemorrhagic detachment and the formation of a fibrovascular scar [4].

Myopia is characterized not only by refractive error but also by irreversible retinal changes presenting as peripheral chorioretinal lesions in the equatorial region, such as lattice dystrophy, pathological hyperpigmentation, and retinal tears [5, 6]. In myopia, accommodation undergoes changes manifested by the reduced functional capacity of the ciliary muscle. This leads to an accommodative insufficiency characterized by decreased functional lability of the ciliary muscle, which contributes to the elongation of the anteroposterior diameter of the eyeball [7].

Some patients develop systemic hypotension accompanied by blood flow deceleration, revealing a significant suppression of the antioxidant system, hypoxia, increased blood viscosity, as well as ischemic and dyscirculatory changes in ocular hemodynamics. A reduction in volumetric blood flow within myopic eyes reduces perfusion pressure and decreases the tolerance of the optic nerve head and retina, which worsens the prognosis [8, 9].

The application of various conservative treatment modalities for progressive myopia is not always effective. Among the surgical interventions aimed at stabilizing the progression of myopia, xenotransplantation is used in many Muslim countries where the use of cadaveric alloplants is prohibited [10]. Recently, the emergence of modern diagnostic technologies has made it possible to investigate highly delicate ocular structures and evaluate the in vivo changes occurring within them [11, 12]. One such method is Doppler ultrasonography of the retinal vessels, which allows for the assessment of blood circulation, recording of blood flow in the retrobulbar orbital space, and tracking of dynamic blood flow patterns around the optic nerve and within the vessels traversing it.

Purpose – to evaluate the efficacy of xenoscleroplasty in progressive myopia complicated by chorioretinal dystrophy using the method of dynamic assessment of hemodynamics in the ophthalmic artery basin.

Material and methods

Clinical studies were conducted in two groups of patients presenting with progressive myopia complicated by chorioretinal dystrophy: a control group consisting of 10 patients (16 eyes) who received conservative treatment methods only, and a study group comprising 36 patients (70 eyes) who underwent xenoscleroplasty. Myopic refraction ranged from (-) 9.0 D to (-) 22.0 D, and patient age ranged from 12 to 43 years. The study group included 17 men and 19 women. All patients underwent a comprehensive battery of standard ophthalmological examinations: visometry, perimetry, autorefractometry, tonometry, ultrasonography (A- and B-scanning of the eyeball, along with Doppler imaging of the ophthalmic artery and its branches), and

optical coherence tomography (OCT). Llinear BFV was evaluated in the ophthalmic artery, central retinal artery, and posterior ciliary arteries over a one-year period: at baseline (before treatment), and post-intervention at 10 days, 1 month, and every 3 months thereafter in the study group, and before and after conservative therapy in the control group. BFV was assessed using a Samsung Medison V7 ultrasound scanner equipped with a wide-format 21.5" Full HD LED monitor and an integrated color, power, and highly sensitive pulsed-wave Doppler module (CA3-10A single-crystal convex transducer, 3-10 MHz).

Surgical Technique

Following sub-Tenon's anesthesia with a 1% lidocaine solution, an incision was made through the conjunctiva and Tenon's capsule in the superotemporal quadrant at a distance of 8-10 mm from the limbus. A narrow tunnel was then created toward the posterior pole of the eye using a curved spatula. A disc-shaped flap measuring 1.0 × 1.2 cm was modulated from the xenograft biomaterial. The xenograft is manufactured from ovine pericardium (Uzbekistan 02-03/145, 28.03.2003). Using specialized curved forceps, the xenograft was implanted into the retrobulbar space in the projection of the macula lutea (Patent No. 2003122500, FIPS Russia, 2003) [7]. To complete the procedure, an interrupted suture was placed on the conjunctival wound (**Figure 1, a–e**).

Patients in the control group systematically received conservative therapy twice a year, aimed at improving the trophic status of the retina and the uveal tract of the eyeball: “Actovegin” 5.0 mL + 0.85% sodium chloride 250 mL, administered intravenously once daily for 10 days; 1% “Emoxipine” solution 1.0 mL, administered parabulbarly for 10 days; “Cortexin” 10.0 mL + 0.5% novocaine 2.0 mL, administered via the lymphotropic route.

Statistical analysis was performed using the "OpenEpi 2009, Version 2.3" statistical software package. Descriptive statistics were completed by calculating the mean value and its standard error (M±m), along with the 95% confidence interval; a frequency analysis of the studied variables was also conducted.

Results

Based on the results of the preoperative ophthalmological examination of the study group, patients were conventionally subdivided into two subgroups:

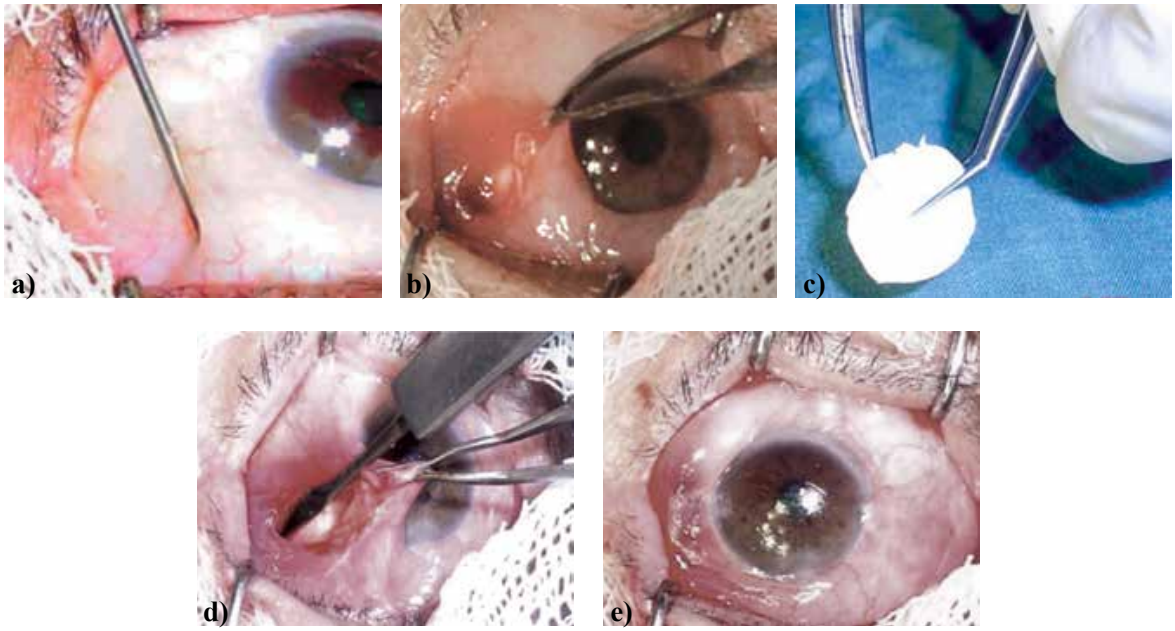

Figure 1. *Surgical technique of xenoscleroplasty: a) sub-Tenon's anesthesia; b) creation of a tunnel in the superotemporal quadrant; c) disc-shaped xenograft; d) implantation of the xenograft into the retrobulbar space; e) placement of an interrupted suture on the conjunctiva.*

Table 1. *Dynamics of ultrasound Dopplerography parameters in the ophthalmic artery in progressive myopia with chorioretinal dystrophy.*

Linear blood flow velocity, (M ± m, cm/s)	*Study group*		*Control group*	
	Before surgery	After surgery	Before treatment	After treatment
Ophthalmic artery	23.60±0.01	26.70±0.03*	25.71±0.03	23.21±0.03
Central retinal artery	5.60±0.02	6.70±0.03*	5.71±0.03	4.71±0.03
Medial short posterior ciliary arteries	10.71±0.03	15.71±0.03	10.71±0.03	9.71±0.03
Lateral short posterior ciliary arteries	13.71±0.03	15.71±0.03	13.71±0.03	11.71±0.03

Note: ** – significant difference between preoperative and postoperative values (P < 0.01).*

1) A subgroup of patients presenting with a myopic refraction ranging from 9.0 to 13.0 diopters accompanied by peripheral chorioretinal dystrophy (19 patients). In these patients, visual acuity was 0.06 uncorrected and 0.3 with correction. The visual field was constricted by an average of 20 ± 0.01 degrees. Intraocular pressure (IOP) remained within limits at ≤20 mmHg. OCT examinations revealed that, in the first subgroup of patients, thinning of the retinal epithelium in the macular region was observed, with a mean thickness of 198 ± 0.02 µm. A-scan ultrasonography showed elongation of anteroposterior (AP) dimension of the eyeball, with a mean value of 25.75 ± 0.02 mm.

2) A subgroup of patients with a myopic refraction ranging from 14.0 to 22.0 diopters (17 patients). In these patients, visual acuity ranged from 0.02 to 0.05 without correction and from 0.06 to 0.1 with correction. The visual field was constricted by an average of 35 ± 0.03 degrees. IOP remained within limits at ≤19 mmHg. OCT examinations showed thinning of the retina in the macular region, with values of 175 ± 0.01 µm. The AP diameter averaged up to a mean of 27.25 ± 0.01 mm. Furthermore, posterior hyaloid

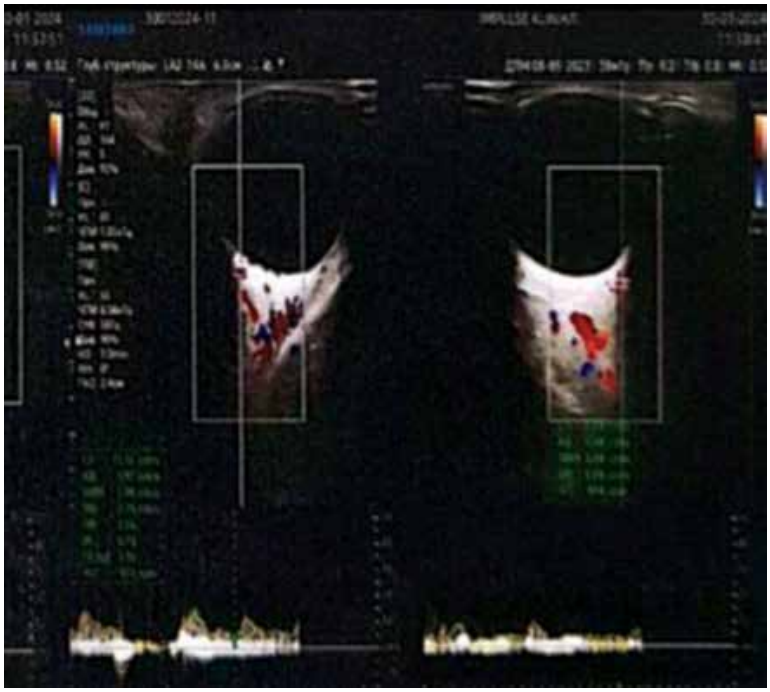

Figure 2. *Ultrasound Doppler scan of the ophthalmic artery vascular basin prior to surgery: Right eye - blood flow velocity in the ophthalmic artery was 26.9 cm/s; central retinal artery - 18.9 cm/s; medial short posterior ciliary artery - 8.5 cm/s; lateral short posterior ciliary artery - 10.2 cm/s; Left eye: blood flow velocity in the ophthalmic artery was 25.7 cm/s; central retinal artery - 21.8 cm/s; medial short posterior ciliary artery - 13.0 cm/s; lateral short posterior ciliary artery was 14.7 cm/s.*

Figure 3. *Ultrasound Doppler scan of the ophthalmic artery vascular basin 4 months postoperatively: Right eye - blood flow velocity in the ophthalmic artery was 33.5 cm/s; central retinal artery was 21.0 cm/s; medial short posterior ciliary artery was 11.7 cm/s; lateral short posterior ciliary artery was 15.5 cm/s.; Left eye - blood flow velocity in the ophthalmic artery was 39.6 cm/s; central retinal artery was 24.6 cm/s; medial short posterior ciliary artery - 16.1 cm/s; lateral short posterior ciliary artery was 18.4 cm/s.*

membrane detachment of the vitreous body was noted in 7 cases within this subgroup. Additionally, floating vitreous opacities were recorded in all cases of myopia.

Table 1 presents the comparative data of our investigation regarding the hemodynamic parameters in the ophthalmic artery in both patient groups.

As shown in the table, a significant improvement in regional hemodynamics was observed postoperatively in the study group. Based on the mean calculations of the postoperative Doppler parameters performed over time, an increase in BFV was noted within the ophthalmic artery in the study group following xenoscleroplasty; no such changes were recorded in the control group after conservative treatment. Within the study group, the most pronounced acceleration in BFV was observed in the ophthalmic artery and the medial short posterior ciliary arteries. A relatively slower acceleration was observed in the central retinal artery and the lateral short posterior ciliary arteries.

Figures 2 and **3** present the Doppler scans of a female patient diagnosed with progressive high myopia complicated by bilateral chorioretinal dystrophy before and 4 months after xenoscleroplasty, which demonstrated an increase in BFV throughout the ophthalmic artery. This enhancement of BFV within the ophthalmic artery contributed to the improvement of visual functions. Visual acuity increased to an average of 0.06 ± 0.02. On average, the visual field expanded to 20 ± 0.01 degrees.

Discussion

Our findings demonstrated that during the preoperative period, progressive myopia complicated by chorioretinal dystrophy was accompanied by a decrease in BFV across all branches of the ophthalmic artery. Investigating the hemodynamics within the ophthalmic artery branch basins in patients with progressive myopia and chorioretinal dystrophy revealed a correlation between visual impairment and reduced BFV in the ophthalmic, central retinal, and short posterior ciliary arteries. Analogous studies on hemodynamic alterations in chorioretinal complications of progressive myopia confirm that retinal dystrophy and optic disc atrophy

directly depend on a significant reduction in BFV across all branches of the ophthalmic artery [10]. The performed xenoscleroplasty accelerated BFV in the ocular arteries, which, in turn, led to improved microcirculation at the level of the retina and the optic nerve. This effect is attributed to the stimulatory capacity of the implanted xenograft within the retrobulbar region of the eye. Experimental histological studies have proven that during early observation periods, the implanted xenograft induces a reactive inflammatory response accompanied by enhanced hemodynamics around the graft. In the later follow-up stages, neovascularization occurs, with new vessels penetrating through the sclera into the choroid. Consequently, both the local immune and hemodynamic capacities of the eye are activated [13, 14]. As the BFV within the ophthalmic artery basins increased, visual functions improved accordingly [15, 16].

The postoperative acceleration of BFV led to an improvement in visual functions due to the prolonged effect of the xenograft throughout the observation period. Several patients have remained under our follow-up for up to ten years, demonstrating long-term stability of their remaining vision.

In conclusion, our findings demonstrate that ultrasound Dopplerography is a modern, objective, highly effective, and non-invasive modality whose diagnostic capabilities are far from being fully exhausted. Further research will deepen our understanding of the role that hemodynamic disturbances play in the pathogenesis and mechanisms of action of xenoscleroplasty across various stages of progressive myopia complicated by chorioretinal dystrophy. Ultimately, these insights provide a foundation for taking the necessary next steps toward developing novel therapeutic approaches for this pathology.

Conclusion

Xenoscleroplasty for progressive myopia complicated by chorioretinal dystrophy is an effective method for stabilizing retinal dystrophic lesions. Concurrently, Dopplerographic assessments of BFV within the ophthalmic artery basins provide an objective means of evaluating the efficacy of the surgical treatment performed. Longitudinal evaluation of hemodynamics within the ophthalmic artery basin in patients with progressive myopia and chorioretinal dystrophy revealed a post-xenoscleroplasty increase in BFV by an average of 2 cm/s, which likely contributed to the improvement of visual functions..

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