Influence Of Diabetes Mellitus And Cognitive Status On The Progression Of Age-Related Cataract: A Retrospective Clinical-Statistical Study

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ABSTRACT

This article presents a detailed retrospective analysis of comorbidity in patients with age-related cataract. The study covers clinical data from 30 patients, including ophthalmological status, presence of diabetes mellitus, and cognitive function indices. Using variation statistics methods (Student's t-test), the significant influence of hyperglycemia on accelerating the rate of lens degradation was demonstrated. A correlation between visual impairment and reduced cognitive reserve according to MMSE and MoCA scales was identified.

Keywords: age-related cataract, diabetes mellitus, cognitive impairment, Student's t-test, retrospective study

INTRODUCTION

Age-related cataract remains one of the most pressing problems in modern ophthalmology, being the leading cause of reversible vision loss in individuals over 50 years of age. According to WHO expert projections, by 2030 the number of people requiring surgical treatment for cataract may double due to the global trend of population aging.

The modern concept of age-related cataract pathogenesis views it not only as a local lens opacity but also as a marker of biological age and general somatic wellbeing. The lens, being a unique avascular structure, is highly sensitive to metabolic changes in the internal environment of the body. Oxidative stress, non-enzymatic glycation of crystallin proteins, and disruption of osmotic balance are the key mechanisms triggering lens transparency loss.

Of particular interest is the relationship between cataract and type 2 diabetes mellitus (DM). Hyperglycemia leads to activation of the sorbitol pathway of glucose metabolism, causing osmotic swelling of lens fibers and the development of so-called "diabetic cataract," which progresses significantly faster than the ordinary senile form.

Furthermore, in recent years ophthalmologists and gerontologists are increasingly drawing attention to the "sensory-cognitive link." Decreased visual acuity limits the flow of afferent information to the brain, which in combination with general vascular pathologies may accelerate the development of cognitive deficit in elderly patients.

Aim of the study: *To study the features of age-related cataract progression in the context of somatic pathology and to assess the cognitive status of this patient group.*

MATERIALS AND METHODS

We conducted a retrospective analysis of medical records of 30 patients who underwent examination and treatment at the Multidisciplinary Clinic of the Tashkent Medical Academy. The mean patient age was 61.5 ± 4.2 years. Inclusion criteria:

- Diagnosed age-related cataract (initial, immature, or mature stages).
- Presence of documented somatic history.
- Completion of neuropsychological screening.

Research methods:

- **Ophthalmological:** visometry (visual acuity determination), biomicroscopy of the lens in transmitted light.

- **Somatic:** analysis of glycemic profile, assessment of arterial hypertension (AH) and metabolic syndrome.
- **Neuropsychological:** MMSE (Mini-Mental State Examination) scale for general assessment and MoCA (Montreal Cognitive Assessment) scale for detecting mild cognitive impairment.

Data processing was performed using a statistical function package. For quantitative variables, the arithmetic mean (M) and the standard error of the mean (m) were calculated. The significance of differences between groups (patients with and without DM) was determined using Student's t-test. The significance level was set at $p < 0.05$.

RESULTS

1. Analysis of the Somatic Background.

The retrospective analysis established that age-related cataract in the examined patient group almost never occurs as an isolated process. The high comorbidity index (presence of several diseases in one patient) indicates that lens opacity is a local manifestation of systemic aging and metabolic disorganization of the body.

The most significant comorbid condition was arterial hypertension (58%). Chronic elevation of blood pressure leads to microangiopathies of the ocular fundus vessels and disruption of the blood-ocular barrier, which indirectly affects lens nutrition.

Type 2 diabetes mellitus (42%) ranked second in frequency, but it demonstrated the most aggressive effect on the rate of cataract maturation. In patients with DM, the mean disease duration before significant visual loss was 10.5 ± 0.6 years. Pathogenetically, this is explained by accumulation of sorbitol in lens fibers, causing osmotic hyperhydration and subsequent denaturation of crystallin proteins.

Additionally, 29% of patients were diagnosed with metabolic syndrome, including a combination of obesity, dyslipidemia, and impaired glucose tolerance. This confirms the theory that lipid metabolism also plays a role in the stability of lens epithelial cell membranes. Thus, the somatic background of a patient with cataract is characterized by multi-organ pathology, where disorders of carbohydrate and vascular profiles are the dominant risk factors.

Table 1. Structure of concomitant somatic pathology (n=30)

Type of Pathology	Number of Patients	Frequency (%)
Arterial hypertension	17	58%
Type 2 diabetes mellitus	13	42%
Ischemic heart disease	11	37%
Metabolic syndrome	9	29%
Gastrointestinal diseases	7	23%

2. Effect of Diabetes Mellitus on Visual Acuity.

A key stage of the work was comparing visual functions in patients with and without diabetes. The results showed a statistically significant advantage in visual acuity in individuals without carbohydrate metabolism disorders.

Table 2. Comparative characteristics of visual acuity (M ± m)

Study Group	n	Visual Acuity (units)	Error (m)
Patients with DM	18	0.33	0.02
Patients without DM	12	0.78	0.03

Calculation of Student's t-test yielded a value of $t = 9.74$. The critical value for this sample is 2.048. Since $t_{tetp} > t_{cRIT}$, the difference in visual acuity is statistically significant with a probability exceeding 99% ($p < 0.001$). This confirms that DM is an aggressive risk factor for cataract progression.

3. Cognitive Profile and Neuropsychological Status.

Special attention in the study was given to assessing the mental health of patients. There exists a hypothesis of "sensory deprivation," according to which progressive visual impairment in cataract leads to reduced afferent stimulation of the cerebral cortex, which accelerates cognitive decline in elderly individuals.

According to MoCA (Montreal Cognitive Assessment) testing results, the mean score in the study group was 22.5 ± 0.2, which is below the clinical norm of 26 points. This indicates the presence of mild cognitive disorders (MCD).

- **Attention function (6.1 ± 0.14 points):** Patients experienced difficulties with serial counting and concentration tasks. Decreased attention may be associated with both the general vascular background (cerebrovascular insufficiency due to AH) and psychological fatigue from poor vision.
- **Short-term memory (5.1 ± 0.15 points):** The largest number of errors was recorded in delayed word recall.
- **Executive functions (5.6 ± 0.12 points):** Difficulties were identified in tests of abstract thinking and verbal fluency.

Additionally, subjective condition analysis was conducted. 63% of patients regularly reported non-systemic dizziness, and 54% noted insomnia (sleep disorders). The high frequency of dizziness may be caused by disruption of the interaction between the visual and vestibular analyzers — due to the opaque lens, the brain receives distorted information about space, leading to postural instability.

Table 3. Cognitive testing results (mean scores)

Cognitive Function Domain	Mean Score (0–10) / Total	Normative Value
MoCA Scale (total score)	22.5 ± 0.2	≥ 26
Attention	6.1 ± 0.14	10
Short-term memory	5.1 ± 0.15	10
Executive functions	5.6 ± 0.12	10

Table 4. Analysis of subjective complaints and somatic symptoms

Complaint	Frequency (abs.)	Percentage (%)
Decreased visual clarity (blurriness)	30	100%
Dizziness	19	63%
Sleep rhythm disturbance	16	54%
Headaches on exertion	14	47%

Low scores on memory and attention were often accompanied by patient complaints about decreased quality of life. Thus, the neuropsychological status of patients with age-related cataract is characterized by reduced cognitive reserve, which requires particular attention from the ophthalmologist when planning surgery and explaining recommendations, as patients with cognitive deficit absorb information about the postoperative regimen less effectively.

DISCUSSION

Analysis of the data obtained in the course of the study allows for a more detailed interpretation of the mechanisms of interrelation between the state of the lens and the general somatic status of the patient. The central finding of the study was the identification of a statistically significant effect of diabetes mellitus on visual acuity. The obtained Student's t-test value ($t = 9.74$ at $p < 0.001$) indicates that hyperglycemia is not merely a

concomitant factor but a powerful catalyst of degenerative processes in the lens.

The pathophysiological basis of this phenomenon lies in a metabolic "vicious circle": with excess glucose in the aqueous humor of the eye, the enzyme aldose reductase is activated, converting glucose into sorbitol. Sorbitol, possessing high osmotic activity, attracts water into the lens fibers. This leads to their swelling, disruption of protein bonds, and formation of vacuoles, which clinically manifests as rapid decrease of visual acuity to critical values (0.33 ± 0.02).

An equally important aspect is the identified cognitive dysfunction. The mean MoCA score (22.5 ± 0.2) indicates the presence of mild to moderate cognitive disorders in the majority of those examined. We associate this with the phenomenon of "double hit":

- **Vascular component:** Arterial hypertension, found in 58% of patients, leads to chronic ischemia not only of eye structures but also of brain areas responsible for memory and attention.
- **Sensory deprivation:** Reduced flow of visual information (due to the opaque lens) decreases the plasticity of cortical neurons. This explains why patients with the most mature stages of cataract showed lower attention scores (6.1 ± 0.14).

The high frequency of dizziness complaints (63%) also deserves attention. In ophthalmo-geriatric practice, this is often interpreted as a result of disrupted proprioception and visual orientation. When the lens loses its transparency, the brain is deprived of clear spatial landmarks, which against the background of age-related changes in the vestibular apparatus creates a sense of instability.

Thus, the discussion results emphasize: age-related cataract is a multidisciplinary problem. A patient with cataract is often a patient with systemic metabolic disorders and early cognitive changes. This dictates the necessity of including in preoperative preparation not only ophthalmological tests but also glycemic profile monitoring, as well as a neurologist's consultation to assess cognitive status, which will improve the quality of rehabilitation and overall patient satisfaction with treatment outcomes.

CONCLUSION

- Age-related cataract in 82% of patients occurs in combination with somatic pathology, among which arterial hypertension (58%) and diabetes mellitus (42%) are predominant.
- The presence of diabetes mellitus statistically significantly ($p < 0.001$) reduces visual acuity (by an average of 0.45 units compared to the group without diabetes).
- The cognitive status of cataract patients is characterized by mild deficit (MoCA 22.5 points), requiring a multidisciplinary approach involving an ophthalmologist, endocrinologist, and neurologist.

REFERENCES

1. Avetisov S.E. Ophthalmology: National Guidelines. GEOTAR-Media; 2019.
2. Libman E.S. Blindness and disability due to visual organ pathology in Russia. Vestnik Oftalmologii. 2006.
3. Egorov E.A. Age-related cataract: modern aspects of pathogenesis and therapy. Klinicheskaya Oftalmologiya. 2018.
4. Malov I.V. Somatic status of patients with age-related cataract. Kazansky Meditsinskiy Zhurnal. 2010.
5. Trubilin V.N. Modern methods of cataract surgery and concomitant pathology. Oftalmochirurgiya. 2015.
6. Bikbov M.M. Features of cataract surgery in patients with diabetes mellitus. Vestnik Orenburgskogo Gosuniversiteta. 2014.
7. Astakhov Yu.S. Assessment of risk factors for age-related cataract development. Oftalmologicheskie Vedomosti. 2012.
8. Foster A. Vision 2020: The Right to Sight. American Journal of Ophthalmology. 2001.
9. Resnikoff S. et al. Global data on visual impairment in the year 2002. Bull World Health Organ. 2004.

10. Asbell P.A. et al. Age-related cataract. Lancet. 2005.
11. Klein B.E. et al. The Beaver Dam Eye Study: incidence of age-related cataracts. Ophthalmology. 1995.
12. Taylor H.R. Etiology of age-related cataract. Investigative Ophthalmology & Visual Science. 1999.
13. West S.K. Epidemiology of age-related cataract. Eye & Contact Lens. 2007.
14. Brian G., Taylor H. Cataract blindness: challenges for the 21st century. Bull World Health Organ. 2001.
15. Brown N.P. The morphology of cataract and its relation to somatic health. Eye. 1991.
16. Cheng C.Y. et al. Association of cardiovascular disease and risk factors with cataract. Ophthalmology. 2011.
17. Tan J.S. et al. Metabolic syndrome and the 10-year incidence of cataract. American Journal of Ophthalmology. 2008.
18. Delcourt C. et al. Risk factors for cortical, nuclear, and posterior subcapsular cataracts. Archives of Ophthalmology. 2000.
19. Leske M.C. et al. The Case-Control Study of Age-Related Cataract. Archives of Ophthalmology. 1991.