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ORIGINAL ARTICLE

Prevention of pseudoexfoliation glaucoma in patients with age-related cataract in the background of pseudoexfoliation syndrome

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ABSTRACT

Aim: To evaluate the possibility of using cataract phacoemulsification with simultaneous intraocular lens (IOL) implantation in patients with age-related cataract (ARC) combined with pseudoexfoliation syndrome (PES) as an algorithm for the pseudoexfoliation glaucoma (PEG) prevention.

Materials and Methods: A retrospective case-control study was conducted using data from medical records of 610 outpatients (813 eyes) with ARC aged from 49 to 79 years (average age 69 ± 3 years). Group 1 included 488 patients (625 eyes) with ARC and PES, and Group 2 (control) included 122 patients (188 eyes) without signs of PES. Patients in both groups underwent ultrasonic phacoemulsification and IOL implantation.

Results: Patients from Group 1 presented with less anterior chamber depth, a thicker lens, and higher intraocular pressure (IOP), as compared to Group 2. In patients with PES after cataract surgery, we observed a slight increase in IOP during the first week, followed by a significant decrease (by 3.1 mm Hg) during the next 3 months (vs. baseline; $p<0,001$). In patients without PES, a slow decrease in IOP (by 1,0 mm Hg) was observed during 3 months after surgery (vs. baseline; $p<0,001$). The cataract surgery favored an increase in anterior chamber depth by 45,2 % in patients with ARC and PES.

Conclusions: Ultrasonic cataract phacoemulsification with IOL implantation in patients with PES leads to a significant decrease and stabilization of IOP in the long-term postoperative period (3-month follow-up), and may be an alternative method for the prevention of PEG development.

KEY WORDS: prevention, glaucoma, cataract, pseudoexfoliation syndrome, phacoemulsification

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INTRODUCTION

Glaucoma is one of the most common diseases that lead to vision loss, affecting about 8 million people worldwide [1]. This disease is known to occur more often in the elderly, and the main symptoms of glaucoma are elevated intraocular pressure (IOP), optic atrophy, and narrowing of the visual field. Therefore, the basis of glaucoma prevention should be health control of older people, as well as monitoring and prevention of IOP increase in the early stages of the disease.

Glaucoma is associated with heredity, prolonged use of glucocorticosteroids, and the presence of concomitant diseases such as myopia, a history of eye injuries, hypertension, diabetes mellitus, and other chronic conditions. The occurrence of a systemic dystrophic disease, namely pseudoexfoliation syndrome (PES), in patients with age-related cataract (ARC) provokes the development of pseudoexfoliation glaucoma (PEG). This disease, which is characterised by age-related systemic microfibrillopathy, leads to predominant damage to eye tissues with gradual accumulation of exfoliative material on the iris and lens [2–6].

The average age of PES onset ranges from 60 to 70 years. The prevalence of the disease increases with age: in persons aged 50–60 years, PES occurs in 0,7%, and in those aged 80 and older – in 7,3% [4, 5, 7, 8]. The distribution of PES prevalence among men and women is the same. However, it is known that pseudoexfoliation without signs of glaucoma is more common in older women, which is associated with the longer life expectancy of women compared to men.

The exact cause of PES remains unknown. The influence of ultraviolet rays, dietary factors, tobacco smoking, stress, and other unfavourable factors is noted. Mutations in the LOX1 gene (locus 15q22), which encodes components of elastic fibres of the extracellular matrix, are of great importance. The accumulation of exfoliative material in PES is found not only in the tissues of the eyes but also in the skin, brain membranes, gallbladder, and visceral organs. Given the systemic nature of the lesion, PES is considered a risk factor for the development of various vascular diseases, including stroke and heart attack, so the provision of medical care may require the participation of other specialists [9].

Eye lesions are among the most studied localisations of the manifestation of the pathological process in PES. It has been established that PES predominantly affects both eyes, but clinical manifestations are often observed first in one eye and only later in the other eye [10].

PES creates an unfavourable background for the development of other eye diseases, the most important

of which is PEG [5, 8]. PEG is considered to be one of the most resistant to treatment and is the most common cause of blindness [7]. The frequency of PES detection in glaucoma is higher than in non-glaucoma patients [11].

PES often accompanies ARC: the frequency of combinations of these diseases ranges from 24 % to 70 % or more [5, 12]. The combination of ARC and PES is accompanied by changes in various structures of the eye, and morphometric changes in the anterior segment of the eye, such as a decrease in the depth of the anterior chamber and an increase in the thickness of the lens [7, 8].

Reducing IOP to a „target" level that minimizes the development and progression of glaucomatous optic neuropathy is the main goal of the prevention and treatment of any type of open-angle glaucoma, including PES [13]. Scientists have proven that ultrasonic phacoemulsification of ARC leads to a significant decrease in IOP by 1,5–2,5 mm Hg [14-17].

Successful implementation of glaucoma prevention requires a comprehensive, multisectoral approach. This approach suggests effective interaction between ophthalmologists, family doctors, specialists from other related fields, and public health professionals, with the participation of all involved sectors, non-governmental organizations, and the population.

AIM

The work was aimed at assessing the possibility of using cataract phacoemulsification with simultaneous intraocular lens (IOL) implantation in patients with ARC in combination with PES as an algorithm for the prevention of the development of PEG.

MATERIALS AND METHODS

A retrospective case-control study was conducted based on medical records of 610 outpatients with ARC who were treated at LLC "VISIOBUD Clinic" (Kyiv, Ukraine) during 2014–2024. The study was carried out from June 2023 to December 2024. The age range of patients was 49–79 years, and the average age was (mean ± standard deviation) 69 ± 3 years.

The study analysed the data from 813 eyes of 610 patients. Two observation groups were formed: the first group included 488 patients (625 eyes) with ARC in combination with PES, and the second (control) group included 122 patients (188 eyes) without signs of PES. Thus, the ARC and PES combination was observed in (rate ± standard error) 76,9 % ± 1,5 % of the eyes.

Medical records of patients with signs of hyperopia, myopia, and astigmatism of moderate and high degree were excluded from the study.

There were no typical signs of glaucomatous optic neuropathy according to computerised static perimetry and optical coherence tomography.

Patients in both groups underwent ultrasonic phacoemulsification with IOL implantation. All patients underwent assessment of morphometric parameters of the anterior segment of the eye (lens thickness before surgery, anterior chamber depth before and after surgery) in the preoperative and postoperative periods.

The Goldmann applanation tonometry method was used to determine the level of IOP in patients before surgery, and at 1 week, 1 month, and 3 months after surgery.

The operation was performed by a single surgeon using the same equipment. There were no complications during the operation, or in the early (up to seven days), late (up to three weeks), and long-term (three to twelve months) postoperative periods.

Statistical data processing was carried out using Statistica v. 14.0 (TIBCO Software Inc., USA) and EZR v. 1.68. The Shapiro–Wilk test was used to determine the normality of the quantitative data distribution. Quantitative data were presented as median and interquartile range. Qualitative data were presented as absolute and relative (%) frequency with a standard error.

The Mann-Whitney U test was used to compare the quantitative characteristics of two independent samples. The quantitative characteristics at different follow-up stages were compared using the Friedman test, followed by post hoc comparisons by means of the Wilcoxon signed-rank test (with Bonferroni correction).

Differences were considered statistically significant at $p < 0,05$ (with Bonferroni correction).

In this study, the authors adhered to the principles of the Council of Europe Convention on Human Rights and Biomedicine, the World Medical Association Declaration of Helsinki on the ethical principles for medical research involving human subjects, and current Ukrainian regulatory documents. The study design was approved by the local bioethical committee. The retrospective nature of the study excluded the need for patients to complete informed consent forms.

RESULTS

The morphometric parameters of the anterior segment of the eye of patients of both groups in the preoperative period are given in Table 1.

According to the data obtained, before the operation, the depth of the anterior chamber of the eye in the patients of the first group (with ARC and concomitant PES) was on average 0,32 mm less than in patients of the non-PES control group ($p<0,001$); the thickness of the lens was 1,05 mm greater than in patients without PES ($p<0,001$) (Table 1).

IOP levels before and after surgery (ultrasonic phacoemulsification with IOL implantation in patients with ARC and concomitant PES, and patients with ARC without PES, are presented in Table 2.

Before surgical treatment, the average level of intraocular pressure (IOP) in patients with ARC combined with PES was higher than that in the control group by 1,7 mm Hg ($p < 0,001$) (Table 2).

At the 1-week postoperative follow-up, a slight increase in IOP was detected in patients of group 1; the increase was 0,4 mm Hg on average, or 2,2 % ($p < 0,001$). In the control group, a decrease of 0,3 mm Hg, or 1,8 %, was observed ($p<0,001$). This difference in pressure dynamics in the early postoperative period is expected but not clinically significant.

Table 1. The eye anterior segment morphometric parameters before the surgery in the studied groups of the eyes

Parameters	Group 1 (ARC+PES) n = 625	Group 2 (ARC) n = 188	p
Anterior chamber depth, mm	2,76 (2,49-3,13)	3,08 (2,89-3,33)	<0,001
Lens thickness, mm	4,70 (4,45-5,07)	3,65 (3,52-3,81)	<0,001

Table 2. IOP (mm Hg) before and after the surgery in the studied groups of the eyes

Study stage	Group 1 (ARC+PES) n = 625	Group 2 (ARC) n = 188	p'
Before surgery	17,5 (15,5-19,3)	15,8 (14,8-17,2)	<0,001
1 week after surgery	17,9 (16,2-20,4)	15,5 (14,3-16,9)	<0,001
1 month after surgery	15,0 (14,1-16,1)	14,2 (13,5-15,1)	<0,001
3 months after surgery	14,4 (12,8-16,5)	14,8 (14,0-15,7)	0,024
p''	p_{1-2}<0,001 p_{1-3}<0,001 p_{1-4}<0,001 p_{2-3}<0,001 p_{2-4}<0,001 p_{3-4}=0,001	p_{1-3}<0,001 p_{1-4}<0,001 p_{2-3}<0,001 p_{2-4}<0,001 p_{3-4}<0,001	-

Notes: p' – the significance of difference between groups 1 and 2; p'' – the significance of difference within the corresponding group at different study stages: p_{1-2} – between the stage before surgery and 1 week postoperatively; p_{1-3} – between the stage before surgery and 1 month postoperatively; p_{1-4} – between the stage before surgery and 3 months postoperatively; p_{2-3} – between 1 week and 1 month postoperatively; p_{2-4} – between 1 week and 3 months postoperatively; p_{3-4} – between 1 month and 3 months postoperatively

At the 1-month postoperative follow-up, a decrease in IOP was observed in patients of both groups: in group 1, the decrease was 2,5 mm Hg on average, or 14,3% (p<0,001); in the control group, it was 1,6 mm Hg, or 10,1% (p<0,001). At this stage of follow-up, the intergroup difference in IOP remained statistically significant.

In the remote postoperative period (3 months after surgery), the IOP level in patients with ARC and PES was 0,4 mm Hg less than in the control group without concomitant PES (p=0,024). However, at this stage of follow-up, the difference between the groups was clinically non-significant.

During the three-month follow-up period in group 1, a clinically insignificant increase in IOP was observed in the early postoperative phase. However, a subsequent stable decrease in IOP by 3,1 mm Hg, or 17,7% from baseline, was noted (p<0,001).

In the control group, a sustained overall reduction in IOP by 1,0 mm Hg (6,3%) was observed over the three-month follow-up period, which was statistically significant (p<0,001). Notably, a slight, clinically non-significant increase of 0,6 mm Hg was recorded at the three-month follow-up compared to the one-month measurement.

In 75 patients with ARC and PES (100 eyes), the depth of the anterior chamber of the eye in the long-term (3 months) postoperative period was evaluated. The preoperative depth of the anterior chamber ranged from 2,02 to 3,87 mm, with an average of 2,70 (2,49-3,12) mm. Compared with the preoperative data, the average anterior chamber depth in patients with ARC and PES (100 eyes) was 3,92 (3,87-4,07) mm, representing an increase of 1,22 mm (or 45,2% of the baseline value) (p<0,001).

DISCUSSION

The development of ARC in the vast majority of patients was accompanied by changes in the anterior segment of the eye. PES, as a concomitant pathology, was one of the most common background diseases of ARC. There is an opinion that PES, as a systemic dystrophic disease, served as a trigger for cataract and glaucoma [1].

PES occurred in up to 65 % of patients with glaucoma and 50 % of patients with cataract, and later, after cataract surgery, PES was the main risk factor for IOL dislocation [18, 19].

According to the study, during 2014-2024, 813 surgeries were performed in the clinic for patients with cataracts.

It was found that in the vast majority of cases (76,9 %±1,5 %), patients had a cataract against the background of concomitant PES.

The study of morphometric parameters of the anterior segment of the eye showed that patients with ARC and PES presented with less anterior chamber depth and higher lens thickness, as compared to their PES-free counterparts. After ultrasonic phacoemulsification of a cataract with IOL implantation in patients with PES, a significant increase in anterior chamber depth compared to preoperative values was detected. The study also demonstrated, that in the postoperative period, patients with PES showed a decrease in IOP within the first three months, which was typical and coincided with previous studies [16, 19, 20].

Prevention of glaucoma remained an urgent problem in the field of public health, given the rapid increase in its prevalence in Ukraine and the world and a significant causal link with vision loss. Promising areas of further scientific research should included: scientific substantiation of organization and management principles of preventive surgical treatment of patients with combined pathology: ARC and PES by ultrasonic phacoemulsification of cataract with IOL implantation to prevent the development of PEG; scientific justification, development and implementation of a program for monitoring and evaluating the management of prevention of PEG.

CONCLUSIONS

Prevention of the development of PEG is the main goal of diagnostic and therapeutic measures in patients with ARC, and syndrome, which requires the introduction of a systematic approach to its organization. PES is a typical concomitant pathology of ARC, which is confirmed by its detection in 76,9 %±1,5 % of patients examined in the study.

The development of a cataract in patients with concomitant PES is accompanied by morphometric changes in the anterior segment of the eye, characterized by a significantly more pronounced decrease in the depth of the anterior chamber of the eye and an increase in lens thickness compared to morphometric changes in the anterior segment of the eye in patients suffering from a cataract without PES.

Ultrasound phacoemulsification of cataracts with IOL implantation in patients with PES leads to a statistically significant decrease and stabilization of IOP in the long-term postoperative period (3 months follow-up) and can be an alternative method for preventing the development of PEG.

The improvement of PEG prevention in patients with ARC and PES requires further scientific justification, taking into account the degree of risk of PEG development and the effect of ultrasonic phacoemulsification on early and late reduction of IOP.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

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