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Anterior segment morphometric changes and intraocular pressure lowering after phacoemulsification with intraocular lens implantation for the prevention of pseudoexfoliative glaucoma in patients with pseudoexfoliation syndrome

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Purpose: *To assess intraocular pressure (IOP)-lowering and morphometric changes in the anterior segment after phacoemulsification with intraocular lens (IOL) implantation for the prevention of pseudoexfoliative glaucoma in eyes with pseudoexfoliation syndrome (PEX).*
Material and Methods: *Four hundred and eighty eight patients (625 eyes; age, 49 to 79 years) with evidence of senile cataract associated with PEX (group 1) were included in the study. The control group (group 2) included 122 patients (188 eyes) with confirmed senile cataract without PEX. All patients had phacoemulsification with IOL implantation. Goldmann applanation IOP was measured preoperatively and 1 week and 1 and 3 months postoperatively.*
Results: *In eyes of patients with cataract associated with PEX, the anterior chamber appeared to be 0.3 mm shallower, on average, and the anteroposterior axis of the lens, 1.02 mm longer, on average than those in eyes of patients with cataract without PEX. In addition, in eyes of the former patients, the anterior chamber showed a 30% increase in depth after cataract surgery compared to baseline. We also determined IOP values in eyes of patients with PEX and those without PEX before and after phacoemulsification with IOL implantation. Eyes of the latter patients showed a gradual 1.4-mm Hg reduction in IOP over 3 months after surgery, whereas eyes of the former patients showed an insubstantial IOP increase at 1 week, and a significant 3-mm Hg IOP lowering at 3 months after surgery.*
Conclusion: *In eyes with PEX, cataract was accompanied by morphometric anterior segment changes, with 0.3-mm greater anterior chamber shallowing and 1.02-mm greater elongation of the anteroposterior axis of the lens, compared to eyes without PEX. At 3 months after phacoemulsification with IOL implantation, eyes with PEX showed a percentage IOP reduction of 16.9%.*

Keywords:
cataract, intraocular pressure, glaucoma, pseudoexfoliation syndrome, phacoemulsification, glaucoma

Introduction

Pseudoexfoliation syndrome (PEX) is a systemic disease characterized by the presence of grayish-white exfoliative material accumulated in ocular and other tissues. In 1917, Lindberg was the first to observe accumulation of grayish-white material along the papillary margin in 50% of his patients with glaucoma. Vogt described the disease to which he later gave the name “Exfoliatio superficialis capsulae anterioris” (superficial exfoliation of the anterior lens capsule), and believed that the material could originate from peeling of the anterior lens capsule [1-4]. Dvorak-Theobald was the first to introduce the term “pseudoexfoliation of the lens capsule” to differentiate this entity from true exfoliation in 1954 [1, 4]. PEX affects mostly elderly individuals, both males and females. The average age of the affected individuals in the early disease ranges from 60 to 70 years, and the prevalence increases with age [2-5].

The exact cause of PEX is still not known. Possible contributing factors include exposure to ultraviolet radiation and nutritional factors. PEX has been shown to demonstrate strong familial aggregation that is consistent with inherited disorders. Exfoliative material is produced and accumulates in ocular tissues and visceral organs due to age-related changes in the extracellular matrix in PEX [5]. The eye is one of the best studied locations of manifested pathological process. PEX often affects both eyes, but can be very asymmetric; evidence suggests that progression to bilateral involvement occurs in up to 50% of patients within 5-10 years after the diagnosis. Small flakes of material, resembling dandruff, tend to accumulate on the surface of the anterior capsule of the lens, ciliary

processes and zonules, trabecular structures, and the anterior chamber angle, and sometimes can be found on the corneal endothelium and anterior hyaloid membrane of the vitreous. Clinical-histopathologic correlations focus on the involvement of lens (PEX-phacopathy), zonular apparatus (zonulopathy), ciliary body (cyclopathy), iris (iridopathy), trabecular meshwork (trabeculopathy), and cornea (corneal endotheliopathy) [3-5] leading to numerous ocular complications, the most important of which is pseudoexfoliation glaucoma (PEG).

PEG is believed to be one of the most severe and most resistant to treatment forms of glaucoma, and has been reported to be one of the most common causes of glaucoma-related blindness [5]. Studies have found that PEX occurs at a higher rate in individuals with glaucoma than in individuals without glaucoma. PEX can be expected in patients with senile cataract (especially nuclear senile cataract with a thickened lens) and occurs in 24 to 70 percent of these patients. Cataract opacities in PEX are accompanied by destructive changes in zonular fibers with slit-lamp biomicroscopy evidence of vibration of the iris and lens [5]. The development of cataract in PEX is accompanied by morphometric changes in the anterior segment, with a shallow anterior chamber depth and elongated anteroposterior axis of the lens [6].

The goal of treatment for primary open-angle glaucoma (including PEG) is to reach a target intraocular pressure (IOP; the IOP level at which further glaucomatous optic neuropathy is unlikely to occur) [7]. It has been demonstrated [6, 8] that in eyes with senile cataract, phacoemulsification resulted in an IOP reduction of 1.5 to 2.5 mm Hg, and this reduction was statistically significant. It is believed that the IOP-lowering effect of cataract surgery is caused by morphometric changes in the anterior segment (an increase in anterior chamber depth), with improved aqueous circulation leading to lowering the IOP.

The purpose of this study was to assess IOP-lowering and morphometric changes in the anterior segment after phacoemulsification with intraocular lens (IOL) implantation for the prevention of pseudoexfoliative glaucoma in eyes with PEX.

Material and Methods

Four hundred and eighty eight patients (625 eyes) with biomicroscopic evidence of senile cataract associated with PEX and no optical coherence tomography (OCT) or automated perimetry evidence of glaucomatous optic neuropathy (group 1) were included in the study. The control group (group 2) included 122 patients (188 eyes) with confirmed senile cataract without PEX. Patients in both groups had phacoemulsification with IOL implantation.

Morphometric parameters of the anterior segment (the anteroposterior axis of the lens and anterior chamber depth) were assessed preoperatively and postoperatively. Goldmann applanation IOP was measured preoperatively and 1 week and 1 and 3 months postoperatively.

Patient age ranged from 49 to 79 years (mean age, 69 ± 2.8 years). Patients with signs of moderate or severe ametropia (hypermetropia, myopia or astigmatism) were not included in the study. The surgeries were performed by the same surgeon using the same equipment. There were no intraoperative or early postoperative complications.

Data are presented as mean and mean standard error. Student t test was used to assess differences between groups for parametric data. A significance level of $p < 0.01$ was chosen. Excel software was used for statistical analysis.

The procedures followed were in accordance with the ethical standards of the Helsinki declaration. The study was conducted in compliance with the requirements of the Council of Europe Convention on Human Rights and Biomedicine, and relevant laws of Ukraine.

Results

Preoperative morphometric parameters of the anterior segment for both groups are presented in table 1.

In patients with senile cataract associated with PEX (group 1), preoperative anterior chamber depth ranged from 1.82 to 4.37 mm (mean value, 2.78 mm), and preoperative anteroposterior axis of the lens, from 3.82 to 5.38 mm (mean value, 4.72 mm). In patients with senile cataract without PEX (group 2), preoperative anterior chamber depth ranged from 2.69 to 3.86 mm (mean value, 3.08 mm), and preoperative anteroposterior axis of the lens, from 3.31 to 4.98 mm (mean value, 3.70 mm).

In eyes of patients with cataract associated with PEX, the anterior chamber appeared to be 0.3 mm shallower, on average, and the anteroposterior axis of the lens, 1.02 mm longer, on average than those in eyes of patients with cataract without PEX.

In addition, late postoperative anterior chamber depth was assessed in 75 patients (100 eyes), and ranged from 3.85 to 4.38 mm (mean value, 3.98 ± 0.25 mm), which was 1.2 mm (43%) deeper, on average, compared to the preoperative measurements ($P < 0.01$).

Preoperative and postoperative IOP values for patients with cataract associated with PEX and patients with cataract without PEX in are presented in table 2. In group 1, mean IOP was 17.7 mm Hg before surgery, insignificantly increased to 18.4 mm Hg at week 1, and significantly decreased to 14.7 mmHg at month 3. In group 2, mean IOP was 16.4 mm Hg before surgery, and gradually decreased to 15.0 mm Hg at month 3.

Mean preoperative IOP was 1.3 mm Hg higher in patients with cataract associated with PEX compared to patients with cataract without PEX ($p < 0.01$). In addition, mean postoperative IOP reduction was greater in the former patients than in the latter patients (3 mm Hg (16.9%) versus 1.4 mm Hg (8.5%), $p = 0.005$). At 3 months after surgery, in patients with cataract associated with PEX, mean IOP was 14.7 mm Hg, which was 0.3 mm Hg lower than in patients with cataract without PEX (15.0 mm Hg), but the difference was not significant ($p > 0.01$).

Table 1. Morphometric parameters of the anterior segment prior to cataract surgery

Parameter	Group1 , 625 eyes M ± m	Group 2, 188 eyes M ± m	Significance, as assessed by Student t test
Anterior chanber depth, mm	2.78±0.22	3.08±0.1	P < 0.01*
Anteroposterior axis of the lens, мм	4.72±0.22	3.7±0.28	P < 0.01*

Note: *, significant difference between groups

Table 2. Intraocular pressure (IOP) values for patients with cataract associated with pseudoexfoliation syndrome (PEX) and patients with cataract without PEX

	Group 1, 625 eyes M ± m	Group 2, 188 eyes M ± m	Significance, as assessed by Student t test
Prior to surgery, mm Hg	17.7±2.9	16.4±2.4	P<0.01*
Week 1 after surgery, mm Hg	18.4±2.4	16.0±3.1	P<0.01*
Month 1 after surgery, mm Hg	15.2±2.0	14.4±2.1	P<0.01*
Month 3 after surgery, mm Hg	14.7±3.6	15.0±2.6	P>0.01

Note: *, significant difference between groups

Discussion

In most patients, the development of senile cataract parallels changes in the anterior eye. PEX is one of the most common complications of senile cataract. In the current study, of the 813 eyes operated for cataract during an arbitrary chosen period of 3 months, 625 (76.9%) were found to have PEX.

We found differences in morphometric parameters of the anterior segment (such as the anteroposterior axis of the lens and anterior chamber depth) between eyes with PEX and those without PEX. In eyes of patients with cataract associated with PEX, the anterior chamber appeared to be 0.3 mm shallower, on average, and the anteroposterior axis of the lens, 1.02 mm longer, on average than those in eyes of patients with cataract without PEX. In addition, in the former eyes, late postoperative anterior chamber depth was 1.2 mm (43%) deeper, on average, compared to the preoperative measurements ($P < 0.01$).

Moreover, we observed an IOP reduction over 3 months after surgery in those eyes, which is in agreement with findings of others [9, 10, 11]. Mean postoperative IOP reduction was greater in the eyes without PEX than in the eyes with PEX (3 mm Hg (16.9%) versus 1.4 mm Hg (8.5%)). We believe that a more substantial postoperative IOP reduction in the eyes with PEX could be explained by postoperative changes in the anterior segment, with a postoperative increase in anterior chamber depth of 1.2 mm (43%) compared to the preoperative measurements.

Conclusion

PEX is a typical complication of senile cataract, and was found in 76.9% of eyes with senile cataract in the current study. In eyes with PEX, cataract is accompanied by morphometric anterior segment changes in the form of greater anterior chamber shallowing and greater elongation of the anteroposterior axis of the lens. At 3 months after phacoemulsification with IOL implantation, eyes with PEX showed a percentage IOP reduction of 16.9%. Phacoemulsification with IOL implantation in eyes with PEX warrants further research as a potential alternative method of the prevention of pseudoexfoliation glaucoma via a significant late postoperative IOP lowering (at 3 months).

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Abbreviations: *ACA, anterior chamber angle; IOL, intraocular lens; IOP, intraocular pressure; PEX, pseudoexfoliation syndrome*