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Pseudoexfoliation syndrome: Effect of phacoemulsification on intraocular pressure and its diurnal variation

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Abstract

Purpose: To evaluate the effect of phacoemulsification on intraocular pressure (IOP) in pseudoexfoliation (PEX) syndrome and its diurnal variation.

Methods: In this prospective, non-comparative, interventional case series, phacoemulsification was done for patients with PEX and concomitant visually significant cataract. Follow-up examinations including IOP measurement were done at postoperative day 1, week 1, month 1, month 3, and month 6. All IOP measurements were performed twice daily: once in the morning between 8 and 10 AM and the other in the evening between 6 and 8 PM. The minimum and maximum IOP and the mean IOP were recorded. IOP variation was defined as the difference between maximum and minimum pressures.

Results: Sixty-eight eyes of 68 patients were analyzed. The mean IOP dropped from 17.45 $\pm$ 3.32 mm Hg to 12.57 $\pm$ 1.58 mm Hg at 6 months. The minimum and maximum IOP dropped from 14.97 $\pm$ 3.46 mm Hg and 20.03 $\pm$ 3.39 to 11.53 $\pm$ 1.79 mm Hg and 13.01 $\pm$ 1.81 after 6 months, respectively. Diurnal IOP variation dropped from 5.06 $\pm$ 1.85 mm Hg (range 2–10) at baseline to 1.49 $\pm$ 0.93 mm Hg (range 0–4) at postoperative month 6 ($p < 0.001$ for all). This drop was not correlated with age and CCT, but was strongly correlated with baseline IOP variation ($r = 0.847$, $p < 0.001$).

Conclusion: Phacoemulsification without any additional intervention can be an attractive choice in managing the IOP and its diurnal variations in pseudoexfoliation patients, even with elevated IOP, who do not have advanced optic nerve damage.

Keywords: Phacoemulsification; Pseudoexfoliation; Diurnal intraocular pressure variation

Introduction

Pseudoexfoliation (PEX) syndrome is an age-related systemic disease, with primarily ophthalmic manifestations. It is characterized by accumulation of abnormal extracellular fibrillary material on pupillary border, lens capsule, angle, and other tissues of the body.[1–3] Cataract and glaucoma are two main complications of the disease. In fact, PEX is the most common identifiable cause of open-angle glaucoma worldwide.[4–7] High baseline intraocular pressure (IOP) and high diurnal IOP fluctuation even in normotensive eyes with PEX are considered major risk factors for the development and progression of glaucoma.[8,9] Although the beneficial effect of cataract surgery on IOP drop in PEX patients has been reported in previous studies,[10–12] few studies have analyzed its effect on minimum and maximum IOP, and especially its diurnal variations in PEX patients.

The aim of this study was to evaluate the role of phacoemulsification on IOP changes and its diurnal variations in pseudoexfoliative eyes with concomitant visually significant cataract (Fig. 1).

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Methods

In this prospective, non-comparative, interventional case series, 76 eyes of 76 patients with PEX and concomitant visually significant cataract from January 2012 to February 2013 were included. All patients had been referred to Farabi Eye Hospital, a university-based tertiary care center. The study protocol was approved by the Ethics Committee of Tehran University of Medical Sciences, and patients who agreed and signed the informed consent form were enrolled.

Inclusion and exclusion criteria

Pseudoexfoliation syndrome was diagnosed clinically as presence of white fluffy dandruff-like material on the pupillary border, the lens capsule, or the angle. In patients with bilateral disease, only the eye with more advanced cataract was included in the study.

Patients with a history of ocular trauma or surgery, as well as those with any other coexistent ocular disease including any sign of glaucomatous optic neuropathy such as pathologic optic disc cupping, neuroretinal rim notching, or asymmetric cup to disc ratio (difference in cupping of > 0.2) were excluded from the study. Patients with severe phacodonesis and subluxated lens, posterior synechiae, laser iridotomy, and patients with posterior capsule rupture during the surgery were also excluded. Only those who completed at least 6 months of follow-up were included in the final analysis (68 cases).

Preoperative assessments

Preoperatively, a comprehensive ophthalmic examination including slit lamp examination, Goldmann applanation tonometry, gonioscopy, dilated fundus examination, and visual filed evaluation were done for all patients. Patients demographics and baseline characteristics including age, gender, Snellen chart best corrected visual acuity [converted to logMAR unit (logMAR BCVA)], and central corneal thickness (CCT), measured ultrasonically (Nidek UP-1000 Ultrasonic Pachymeter), were recorded. All IOP measurements were performed twice daily: once in the morning between 8 and 10 AM and the other in the evening between 6 and 8 PM. The minimum and maximum IOP and the mean IOP were recorded. Diurnal IOP variation was defined as the difference between maximum and minimum pressures.

Surgical technique and follow-up method

All patients underwent phacoemulsification by the same surgeon (G.F.). Briefly, under topical anesthesia and through a 3.2 mm-sized, temporal, clear-corneal incision, ocular viscoelastic agent was injected into the anterior chamber (AC), and a continuous curvilinear capsulorhexis was fashioned. Thereafter, hydrodissection, using balance salt solution (BSS), was done on a 25-gauge blunt needle. Phacoemulsification was then carried out, and a one-piece acrylic intraocular lens (AcrySof SA60AT, Alcon Laboratories, Inc., Fort Worth, TX) was implanted in the lens capsular bag. In the end, the AC was reformed with BSS, and corneal incisions were made watertight. Postoperatively, patients were given topical antibiotic and steroid eye drops, both of which were administered four times a day for one week; the latter was tapered within one month.

Follow-up examinations including IOP measurement were done at postoperative day 1, week 1, month 1, month 3, and month 6. More frequent visits were scheduled if needed based

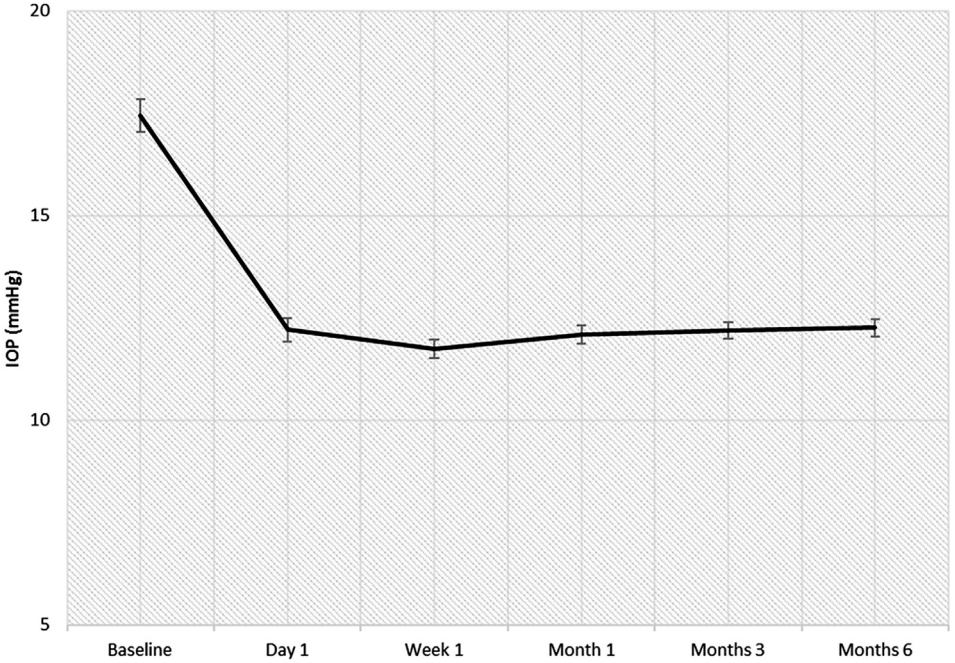

Fig. 1. Intraocular pressure trend during follow up period (mean ± standard error). IOP = intraocular pressure.

on the postoperative ocular examination, and any complication or condition was addressed accordingly.

Statistical analysis

Statistical analysis was performed using SPSS for Windows version 16 (SPSS Inc, Chicago, IL). Results have been reported as mean ± standard deviation (SD) for quantitative variables and as percentages for categorical variables. Paired Student's t test was used for the evaluation of continuous variable changes pre- and postoperatively. The Pearson Product Moment Correlation Coefficient was used to evaluate the correlation between the two continuous variables. For all measurements, a two-tailed test was used, and a p value of < 0.05 was considered significant.

Results

A total of 68 eyes of 68 patients were analyzed. Patient demographics and baseline characteristics are summarized in Table 1.

The mean IOP dropped from 17.45 ± 3.32 mm Hg (range 12.5–25.5) at baseline to 12.57 ± 1.58 mm Hg (range 9–16) at postoperative 6 months ($p < 0.001$). Mean IOP drop at 6 months was not correlated with age (r = 0.057, $p = 0.643$) or CCT (r = 0.009, $p = 0.944$), but was moderately correlated with the baseline Mean IOP (r = 0.601, $p < 0.001$).

The minimum and maximum IOP dropped from 14.97 ± 3.46 mm Hg (range 10–23) and 20.03 ± 3.39 (range 15–28) at baseline to 11.53 ± 1.79 mm Hg (range 9–16) and 13.01 ± 1.81 (range 10–17) ($p < 0.001$ for both) at postoperative 6 months, respectively. The minimum IOP drop at 6 months was not correlated with age (r = 0.071, $p = 0.564$) or CCT (r = 0.066, $p = 0.594$), but was strongly correlated with baseline minimum IOP (r = 0.872, $p < 0.001$). Similarly, the maximum IOP drop at 6 months was not correlated with age (r = − 0.068, $p = 0.584$) and CCT (r = −0.37, $p = 0.765$) but was strongly correlated with baseline maximum IOP (r = 0.860, $p < 0.001$).

Table 1
Patient demographics and baseline characteristics (n = 68).

Variable[a]	Description
Age (year)	68.84 ± 6.62 (55–85)
Gender:	
Male	42 (61.8%)
Female	26 (38.2%)
CCT	533.19 ± 17.03 (485–573)
Mean IOP (mm Hg)	17.45 ± 3.32 (12.5–25.5)
Minimum IOP (mm Hg)	16.69 ± 3.91 (10–25)
Maximum IOP (mm Hg)	18.31 ± 4.45 (11–28)
Diurnal IOP variation (mm Hg)	5.06 ± 1.85 (2–10)
BCVA (LogMAR)	0.92 ± 0.46 (0.5–2.2)

CCT: central corneal thickness; BCVA: best corrected visual acuity; IOP: intraocular pressure; LogMAR: logarithm of minimal angle of resolution.

[a]All numerical variables are presented as mean ± standard deviation (range), and categorical variables are presented as number (percent).

Diurnal IOP variation dropped from 5.06 ± 1.85 mm Hg (range 2–10) at baseline to 1.49 ± 0.93 mm Hg (range 0–4) at postoperative 6 months ($p < 0.001$). This drop was not correlated with age (r = −0.188, $p = 0.124$) or CCT (r = −0.151, $p = 0.218$), but was strongly correlated with baseline diurnal IOP variation (r = 0.847, $p < 0.001$).

Discussion

Although cataract surgery has been shown to reduce baseline IOP both in PEX and normal eyes,[10–15] there are a few reports about the effect of this procedure on diurnal IOP variations.

In our study there was a significant IOP reduction in mean, minimum, and maximum IOP in all post-operative visits (p-value < 0.001 for all). We observed about 5 mm Hg reduction in baseline mean IOP in eyes with PEX and associated cataract at 6 months post cataract surgery follow-up. Merkur et al. in a study have reported a similar amount of IOP drop (4.52 mm Hg) after uneventful phacoemulsification in PEX patients in the same follow-up period.[14] With a longer follow-up, this IOP drop is less pronounced, but still significant.[14,16] Many studies have reported greater IOP reduction with cataract extraction in PEX eyes than those without this pathology, with or without glaucoma.[14,15,17]

In the present study, both minimum and maximum IOP drop and also diurnal IOP variation drop were positively correlated with baseline respective values; the higher the baseline IOP or diurnal IOP variation, the greater drop. Many previous studies have also confirmed this correlation in PEX eyes with or without glaucoma[13,16] as well as in non-PEX eyes either with or without preoperative ocular hypertension[18] or glaucoma.[19] Therefore, it can be inferred that crystalline lens plays a major role in IOP elevation in all eyes, partly due to shallowing of the anterior chamber, and hence, its removal results in a significant IOP drop with direct correlation with baseline IOP. Theoretically, removing the thickened crystalline lens and replacing it with a thin IOL should relieve some of the aqueous drainage impedance through angle. Moreover, cataract extraction removes the anterior lens capsule, which may be one of the main sources of exfoliative material. It may also wash out the present PEX materials and pigments from trabecular meshwork, hence enhancing aqueous drainage in PEX patients.

High baseline IOP and high IOP fluctuations are accepted as risk factor for progression to exfoliative glaucoma.[9,20] IOP and its diurnal variation are usually higher than primary open-angle glaucoma (POAG), and it has been shown that reduction of both is more effective in PEX than POAG in preventing visual field damage,[7] so controlling intraocular pressure is an important issue to prevent glaucoma in these patients. It seems that blockage of trabecular meshwork with PEX material and pigment and the resultant trabecular cell dysfunction causes IOP elevation in PEX syndrome.[3]

We observed significant flattening of diurnal IOP variation in our patients following phacoemulsification. In fact, none of our patients had diurnal IOP variation of more than 5 mm Hg. We had an average of 3.5 mm Hg reduction in mean diurnal IOP variation at 6 month post cataract surgery which is

comparable to a report by Rao A.[21] In this study, diurnal IOP variation, as well as minimum, peak, and mean IOP were significantly less two months after cataract surgery in PEX irrespective of preoperative anterior chamber depth. Therefore, we can postulate that crystalline lens in PEX syndrome may be one of the sources of IOP rise and fluctuation with some mechanisms other than changes in angle width. May be vascular mechanism are also important in this regard. Vascular involvement ad resultant ischemia in PEX,[1,3,7] may cause transient recurrent uveal congestion which may lead to more reduced uveoscleral outflow at some times. Reduction in the amount of PEX material production surgery possibly reduces these ischemic changes and blunts IOP fluctuations.

The importance of IOP fluctuations in causing glaucomatous damage in PEX cannot be overemphasized. As we found here, cataract surgery can help flatten the spikes in diurnal IOP. Long-term follow-up is worth investigation in this regard.

Although cataract surgery significantly reduces IOP and its fluctuation in PEX syndrome, it does not totally eliminate the risk of glaucoma development. Shingleton et al. have observed that 2.7% of PEX eyes without glaucoma will need to use topical hypotensive agents approximately 3 years after phacoemulsification.[16] This fact, highlights the need for life-long follow-up of these patients. In our study, however, the follow-up was much shorter, none of patient's IOP exceeded 17 mm Hg postoperatively, and none of them needed medication to control their IOP. In a study by Altan et al., none of the nonglaucomatous PEX eyes needed to be treated medically for IOP elevation after phacoemulsification during 32 months of follow-up, which is, again, shorter than the follow-up period of the Shingleton study.[13]

We did not find any significant relation between age and post-operative IOP values. This finding is in accordance with previous studies.[16,21] There was also no significant correlation between CCT and post-operative IOP.

Eyes with intraoperative complications, such as zonular dialysis and posterior capsular tear, were purposely excluded from our study. These eyes may be more susceptible to postoperative IOP spikes and glaucoma development and could skew data analysis.

This study is one of the few assessing the effect of phacoemulsification on diurnal IOP variation in pseudoexfoliation syndrome, however, it has some limitations which should be addressed. Most importantly, the follow-up time is short, which precludes us to have any comments about long-term IOP fluctuations after cataract surgery. In addition, we measured IOP 2 times a day for all patients, and we cannot be sure of the exact maximum and minimum IOP values to calculate the diurnal changes. More studies with more frequent diurnal measurements are useful.

In conclusion, temporal clear corneal phacoemulsification without any additional intervention can be an attractive choice in managing the IOP and its variations in pseudoexfoliation patients even with elevated IOP who do not have advanced optic nerve damage. This option is much simpler and less prone to complications than other surgeries to control IOP. At the same time, the superior conjunctiva remains spared in case future filtration procedures become necessary.

Financial interest

None of the authors has any proprietary or financial interest in the products mentioned in this article. No financial support was received.

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