Original Research Article

The Effect of Cataract Surgery on the Intraocular Pressure in Eyes with and without Pseudoexfoliation Syndrome

ABSTRACT

Aims: To determine the effect of cataract surgery on the intraocular pressure (IOP) in eyes with and without pseudoexfoliation syndrome (PXF).
Study design: prospective, non-randomized, age-matched controlled, clinical study.
Place and Duration of Study: Department of Ophthalmology, Assiut University Hospital, Assiut; Egypt, between January 2015 to December 2016.
Methodology: This study included two groups of non-glaucomatous eyes with visually significant senile cataract: 32 eyes with PXF (PXF group), 32 eyes without PXF (control group). In each group, planned extracapsular cataract extraction (PECCE) was done in 22 eyes and phacoemulsification was done in 10 eyes. IOP was measured at one week, one month and three months postoperatively and compared to the preoperative values.
Results: The difference in mean preoperative IOP between PXF group (14.53mm Hg) and the control group (13.97mm Hg) was insignificant (*P*=0.69). A significantly lower postoperative IOP (*P*<0.001) than the preoperative level was detected at all follow-up visits in both groups. Mean IOP reduction was significantly greater in PXF group than in the control group at one month (*P*=0.014) and three months (*P*=0.012) postoperatively.
Conclusion: IOP significantly decreased after cataract surgery in eyes with and without PXF for up to three months postoperatively. This decrease was significantly greater in PXF group than in the control group at one month and three months postoperatively.

Keywords: Cataract surgery; Pseudoexfoliation syndrome; Intraocular pressure; Planned extracapsular cataract extraction; Phacoemulsification.

ABBREVIATIONS

PXF: Pseudoexfoliation syndrome

IOP: Intraocular Pressure

PECCE: Planned Extracapsular Cataract Extraction

1. INTRODUCTION

Pseudoexfoliation syndrome (PXF) is an age-related disorder of extracellular matrix which is commonly associated with glaucoma and cataract [1]. It is a common disorder in elderly in Upper Egypt [2]. Pseudoexfoliative glaucoma (PXG) tends to have a more severe and rapidly progressive course and poorer response to medications than primary open angle glaucoma [3]. Therefore, it is important to closely monitor and control IOP in eyes with PXF.

Several studies noted a decrease in IOP following cataract surgery, either in eyes with or eyes without PXF [4-6]. Thinking of cataract surgery as an option for reducing the risk of ocular hypertension or PXG in eyes with PXF; especially in the developing countries where close IOP monitoring is a difficult issue is now emerging. The aim of this study was to evaluate the effect of cataract surgery on IOP in eyes with PXF.

2. MATERIAL AND METHODS

This prospective, age-matched controlled study was performed on 64 eyes. Patients who met the eligibility criteria were enrolled into one of two groups: those with PXF (n=32 eyes of 32 patients) as PXF group and those without PXF (n=32 eyes of 32 patients) as a control group.

2.1 INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria were: visually significant senile cataract, age of 50 years or above. The diagnosis of PXF was based on the presence of the exfoliative material on the pupillary border or on the anterior lens capsule with the moth-eaten appearance of the pupil under slit-lamp biomicroscopy.

Exclusion criteria were: eyes with established glaucoma, secondary cataract, subluxated lenses, corneal abnormalities that may interfere with reliable applanation tonometry, previous ocular trauma or surgery, other ocular diseases that may affect IOP (e.g. retinal detachment, evidence of previous attacks of uveitis, diabetic retinopathy) or visual function (e.g. macular degeneration) and intraoperative complications during cataract surgery that may affect the postoperative IOP e.g. posterior capsular rupture with vitreous loss.

2.2 SURGICAL TECHNIQUES

Two surgical techniques were used for cataract extraction either planned extracapsular cataract extraction (PECCE) or phacoemulsification; the choice between the two techniques was based on the degree of nuclear hardness and the appearance of the corneal endothelium by specular reflection. In each group, 22 eyes underwent PECCE and 10 eyes underwent phacoemulsification. Surgery was performed by the four surgeons involved in the study using the same surgical technique.

PECCE was done by 10-12mm superior limbal incision, capsulotomy, manual nucleus expression, irrigation/aspiration of remaining cortex, placement of a single piece rigid PMMA (Poly Methyl Metha Acrylate) PCIOL (Posterior chamber intraocular lens) (6.5mm optic) into the capsular bag and closure of the limbal wound by four to five interrupted 10-0 nylon sutures.

Phacoemulsification was done through 2.5-3 mm clear corneal incision, capsulorhexis, phacoemulsification of the nucleus, cortical aspiration, foldable acrylic hydrophobic PCIOL was implanted into the capsular bag and wound closure by stromal hydration.

Routine ophthalmic examination including visual acuity and IOP was performed and recorded preoperatively and postoperatively at (one day, one week, one month and three months) in a standardized data collection sheet. Visual acuity was measured by Snellen chart and converted into log MAR equivalents. IOP was measured by Goldmann applanation tonometry.

2.3 STATISTICAL ANALYSIS

Data entry and data analysis were done using IBM SPSS (statistical package for social science), Version 20.0. (SPSS Inc., Chicago, Illinois, USA). Microsoft excel 2003 version software was used to compose the figures. Normality for all study variables was assessed using Shapiro-Wilks analysis. Mann-Whitney U test was used to compare the mean IOP, mean IOP change, mean IOP change percentile and mean logMAR V/A between the two study groups and between the two surgical techniques. The Wilcoxon signed-rank test was used to compare between preoperative and postoperative IOP in each group. Multivariate analysis model including all eyes involved in the study; with the final reduction in IOP as a dependent variable and: preoperative IOP, the presence of PXF, the surgical technique, age, and gender as predictor variables, was done. A *P* value of 0.05 or less was considered significant.

3. RESULTS

This study was performed on 64 patients (64 eyes). The PXF group involved 32 patients (32 eyes) and the control group involved 32 patients (32 eyes). Table 1 summarizes the patients' demographics and the *P* value of the difference in the clinical characteristics between the two groups.

Table 1: the patients' demographics and the *P* value of the difference in the clinical characteristics.

group	PXF	Control	*P* value
Age(SD)	66.50±7.624	64.37±6.810	0.24
Gender Male Female	 23 (71.9%) 9 (28.1%)	 17 (53.1%) 15 (46.9%)	0.09
Eye Right Left	 18 (56.3%) 14 (43.8%)	 21 (65.6%) 11 (34.4%)	0.30
Baseline BCVA in logMAR	1.86±0.7	2.09±0.79	0.18
Postoperative BCVA in logMAR at 3 months	0.6±0.29	0.65±0.27	0.61
Baseline IOP(mmHg)	14.53 ±3.253	13.97±2.335	0.69

There was a statistically significant improvement in mean postoperative logMAR BCVA (best corrected visual acuity) from the preoperative value in the two groups (*P*<0.001) at three months. The difference in the final BCVA between the two groups was insignificant (*P*=0.61).

Mean preoperative IOP in PXF group was 14.53±3.253 mmHg (range from 10-23 mmHg) and in the control group was 13.97±2.335 mmHg (range from 10-19 mmHg), the difference between the two groups was statistically insignificant (*P*=0.69).

Mean postoperative IOP was significantly lower than the preoperative level at all postoperative visits (*P* <0.001) in the two groups. Mean postoperative IOP was significantly lower in PXF group than the control group at one month (*P*=0.02) and three months (*P*=0.048) (figure 1).

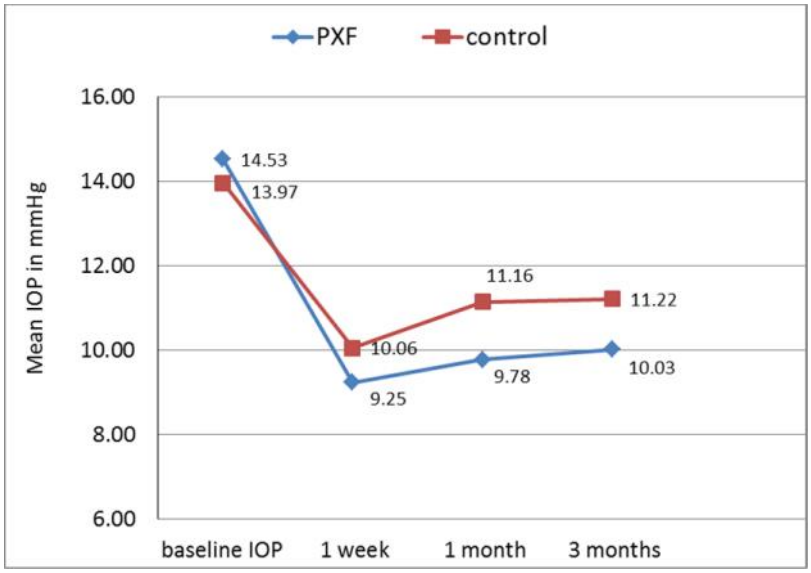

Figure 1: Mean preoperative and postoperative IOP in the two study groups.

The mean IOP change and mean IOP change percentile was significantly greater in PXF group than the control group at one month and three months (table 2).

Table 2: mean preoperative and postoperative IOP, IOP change, IOP change percentile.

	PXF	Control	*P* value
baseline IOP	14.53±3.25	13.97±2.33	0.699
IOP at 1 week	9.25±2.23	10.06±1.95	0.111
IOP change at 1 week	-5.28	-3.91	0.118
IOP change% at 1 week	-34.53%	-26.26%	0.055
IOP at 1 month	9.78±2.82	11.16±1.98	0.02*
IOP change at 1 month	-4.75	-2.81	0.014*
IOP change% at 1 month	-31.23%	-19.09%	0.008*
IOP at 3 months	10.03±2.26	11.22±1.755	0.048*
IOP change at 3 months	-4.50	-2.75	0.012*
IOP change% at 3 months	-29.76%	-18.41%	0.005*

**statistically significant*

In subgroup analysis according to the surgical technique, mean postoperative IOP was significantly lower in PXF group than in the control group only after PECCE at all follow-up visits, but not after phacoemulsification (table 3).

Table 3: comparison of mean preoperative and postoperative IOP, IOP change, IOP change percentile between the two groups using different surgical techniques.

	PECCE			Phacoemulsification		
	PXF	control	*P* value	PXF	control	*P* value
baseline IOP	14.50	14.09	0.859	14.60	13.70	0.353
IOP at 1 week	8.50	9.86	0.014*	10.90	10.50	0.481
IOP change at 1 week	-6.00	-4.23	0.133	-3.70	-3.20	0.353
IOP change% at 1 week	39.05	28.73	0.024*	24.58	20.83	0.481
IOP at 1 month	8.68	10.73	0.003*	12.20	12.10	0.796
IOP change at 1 month	-5.82	-3.36	0.005*	-2.40	-1.60	0.436
IOP change% at 1 month	38.58	23.33	0.001*	15.05	9.76	0.393
IOP at 3 months	9.50	11.14	0.015*	11.20	11.40	0.739
IOP change at 3 months	-5.00	-2.95	0.019*	-3.40	-2.30	0.218
IOP change% at 3 months	32.95	19.99	0.019*	22.75	14.94	0.218

**statistically significant*

Figure 2 shows mean preoperative and postoperative IOP by different surgical techniques in the two study groups.

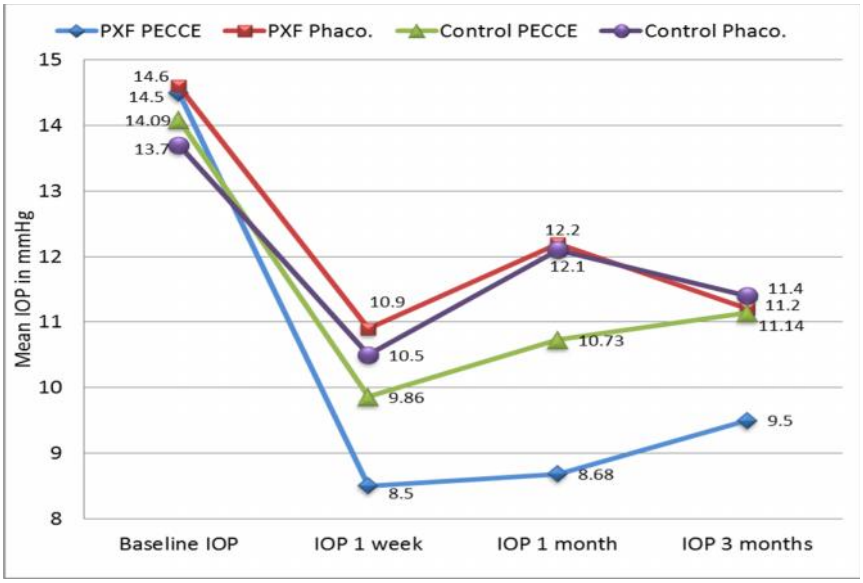

Figure 2: Mean preoperative and postoperative IOP in the two study groups by different surgical techniques.

When comparing PECCE to phacoemulsification in each group separately, mean postoperative IOP was significantly lower after PECCE than after phacoemulsification only in PXF group. The amount of IOP reduction was significantly greater after PECCE than after phacoemulsification in PXF group and the control group only at one month postoperatively. The IOP reduction percentile was significantly greater after PECCE than after phacoemulsification at all follow-up visits in PXF group, but only was significantly greater after PECCE at one month in the control group (table 4).

Table 4: comparison of mean preoperative and postoperative IOP, IOP change, IOP change percentile between the two surgical techniques in different groups.

	PXF			Control		
	PECCE	Phaco.	P value	PECCE	Phaco.	*P* value
baseline IOP	14.50	14.60	0.53	14.09	13.70	0.58
IOP at 1 week	8.50	10.90	0.003*	9.86	10.50	0.56
IOP change at 1 week	6.00	3.70	0.1	4.23	3.20	0.16
IOP change% at 1 week	39.05	24.58	0.02*	28.73	20.83	0.16
IOP at 1 month	8.68	12.20	0.001*	10.73	12.10	0.1
IOP change at 1 month	5.82	2.40	0.009*	3.36	1.60	0.03*
IOP change% at 1 month	38.58	15.05	0.003*	23.33	9.76	0.02*
IOP at 3 months	9.50	11.20	0.03*	11.14	11.40	0.857
IOP change at 3 months	5.00	3.40	0.15	2.95	2.30	0.3
IOP change% at 3 months	32.95	22.75	0.043*	19.99	14.94	0.3

**statistically significant*

Multivariate linear regression analysis; including all eyes involved in the study, demonstrated that: the preoperative IOP (*P* <0.001), the presence of PXF (*P*=0.004) and the type of surgical technique

(*P*=0.045) have a significant impact on the amount of the final IOP reduction at three months, while age (*P*=0.636) and gender (*P*=0.865) have insignificant impacts.

4. DISCUSSION

In this study, we found a significantly lower postoperative IOP in eyes with PXF than in eyes without PXF at one month (*P*=0.02) and three months (*P*=0.048), but not at one week (*P*=0.11).

We performed cataract surgery by two techniques: phacoemulsification and PECCE. Several studies compared the effect of phacoemulsification on IOP in eyes with and without PXF. Some studies found a significantly lower postoperative IOP in eyes with PXF than in those without [7-9]. Other studies failed to detect any significant difference [10-12]. Similarly, we found an insignificant difference between PXF group and the control group after phacoemulsification as regarding postoperative IOP level, postoperative IOP reduction and postoperative IOP reduction percentile at all follow up visits; which is consistent with the finding of the last three studies.

Up to our knowledge, only one study compared the effect of PECCE with PCIOL on IOP in eyes with and without PXF. Rustam et al performed a prospective age-matched study on 40 eyes with PXF and 42 eyes without PXF. The study found a significant IOP decrease at one month and three months postoperatively in both groups. However, there was an insignificant difference in postoperative IOP between both groups [13]. Similarly; our study found that postoperative IOP was significantly lower than preoperative IOP at all follow-up visits in both groups after PECCE with PCIOL. In addition, our study found significantly lower postoperative IOP at all follow-up visits in PXF group than in the control group after PECCE.

The exact mechanism of IOP reduction after cataract surgery is unknown, but it may be due to increase of the anterior chamber depth and widening of its angle after replacing the progressively growing crystalline lens by a thin PCIOL, with backward rotation of the ciliary body and relief of the compression on the trabecular meshwork and Schlemm's canal [5].

In eyes with PXF, weak zonules cause forward shift of the crystalline lens with a reduction in the anterior chamber depth [1]. Thus, it is thought that cataract surgery has a greater impact on deepening of the anterior chamber and widening of its angle in eyes with PXF than in eyes without. This impact could explain why cataract surgery causes greater IOP reduction in eyes with PXF. Güngör et al used Scheimpflug imaging system to compare the change in the anterior chamber depth in eyes with PXF to eyes without PXF after phacoemulsification. They found a significantly more increase in the anterior chamber depth in eyes with PXF than in eyes without PXF [14]. On the other hand, Moghimi et al failed to detect any significant association between changes in IOP after phacoemulsification and anterior segment optical coherence tomography measurements (including preoperative angle, iris or anterior segment parameters) in eyes with PXF [15].

Prostaglandins release after intraocular manipulation cause disruption of the blood-aqueous barrier with protein leakage and IOP elevation for several hours. This is followed by prolonged hypotony secondary to increased uveuoscleral outflow [16]. Prostaglandins have two opposite effects on IOP; ocular hypertensive effect at high concentration and ocular hypotensive effect at low concentration [17]. Oshika et al found that the blood-ocular barrier disruption induced by cataract surgery (either phacoemulsification or PECCE) with abnormally high flare intensity persist for up to six months postoperatively [18]. As the postoperative inflammation is more severe in eyes with PXF than eyes without, it is expected that its hypotensive effect is more pronounced in eyes with PXF [19].

Jacobi et al proposed that the irrigating solutions used during cataract surgery (whose volume reaches up to 40 times the volume of the anterior chamber during PECCE and more than 200 times during phacoemulsification) have a 'rinsing' effect on the pores of the trabecular meshwork [20]. Based on this theory, they developed a new technique called "trabecular aspiration" to wash the accumulated exfoliative materials and pigments in the trabecular meshwork of eyes with PXF. Combined with cataract extraction (by phacoemulsification or PECCE), trabecular aspiration reduced IOP in eyes with PXG by 45% from baseline at 2 years after surgery; whereas a primary therapeutic procedure, trabecular aspiration reduced IOP by 43% from the baseline at 18 months postoperatively [21].

Damji et al thought that the lens removal eliminates the iridolenticular friction and thus reduces the release of pigment from the iris and exfoliative material from the lens and iris [8].

In this study, when we compared PECCE to phacoemulsification. We found that PECCE produced a greater IOP reduction than phacoemulsification. However, the difference in the amount of IOP reduction between the two techniques was only significant at one month. Similar to our finding, Saccà et al. found that PECCE reduced IOP more than phacoemulsification. They explained their finding by the greater prostaglandins release after PECCE than after phacoemulsification [22]. It is known that longer corneoscleral wound of PECCE produces more irritation to the uveal tissues, leading to more release of inflammatory mediators compared to phacoemulsification [18].

In this study, we found that higher preoperative IOP was associated with greater postoperative IOP reduction. Several studies reported the same observation [5, 23].

We found that age and gender did not significantly affect the amount of postoperative IOP reduction. A similar finding was reported by Shingleton et al and Poley et al [4, 5].

The limitations of this study are a low number of eyes operated by phacoemulsification relative to the number of eyes operated by PECCE and a relatively short period of postoperative follow-up. Our study did not evaluate the effect of cataract surgery on glaucomatous eyes. Further studies are needed to evaluate the effect of cataract surgery on IOP in eyes with PXG and to compare its effect alone with combined cataract and incisional glaucoma surgery or staged cataract and incisional glaucoma surgery.

5. CONCLUSION

In conclusion, this study found that cataract surgery in eyes with PXF; either by PECCE or phacoemulsification, reduced IOP for up to three months postoperatively from the preoperative level. This effect can be considered as a protective or therapeutic option against the development of ocular hypertension or PXG in eyes with PXF which is commonly occurred in elderly; for whom regular IOP monitoring is a difficult issue in the developing countries.

CONSENT

A written informed consent was obtained from all patients participated in the study after explaining the whole procedure and possible complications. A copy of the written consent is available for review by the editorial board members of this journal.

ETHICAL APPROVAL

All authors hereby declare that approval was obtained from the Medical Research Ethics Committee of the Scientific Research, Faculty of Medicine, Assiut University that adhered to the tenets of the Declaration of Helsinki.

REFERENCES

1. Schlötzer-Schrehardt U, Naumann GOH. Ocular and systemic pseudoexfoliation syndrome [perspective]. Am J Ophthalmol. 2006; 141: 921–937. DOI: 10.1016/j.ajo.2006.01.047.

2. Shazly TA, Farrag AN, Kamel A, Al-Hussaini AK. Prevalence of Pseudoexfoliation Syndrome and Pseudoexfoliation Glaucoma in Upper Egypt. BMC Ophthalmology 2011;11:18. DOI: 10.1186/1471-2415-11-18.

3. Vesti E, Kivelä T. Exfoliation Syndrome and Exfoliation Glaucoma. Progress in Retinal and Eye Research 2000; 19(3): 345−368. DOI: 10.1016/S1350-9462(99)00019-1.

4. Shingleton BJ, Laul A, Nagao K, Wolff B, O'Donoghue M, Eagan E, et al. Effect of phacoemulsification on intraocular pressure in eyes with pseudoexfoliation. J Cataract Refract Surg. 2008; 34: 1834–1841. DOI: 10.1016/j.jcrs.2008.07.025.

5. Poley BJ, Lindstrom RL, Samuelson TW. Long-term effects of phacoemulsification with intraocular lens implantation in normotensive and ocular hypertensive eyes. J Cataract Refract Surg. 2008; 34: 735−742. DOI: 10.1016/j.jcrs.2007.12.045.

6. Pal VK, Agrawal A, Suman S, Pratap VB. Long-Term Change in Intraocular Pressure after Extracapsular Cataract Extraction with Posterior Chamber Intraocular Lens Implantation Versus Phacoemulsification with Posterior Chamber Intraocular Lens Implantation in Indians. Middle East African Journal of Ophthalmology 2013; 20: 332−335. DOI: 10.4103/0974-9233.120021.

7. Shingleton BJ, Heltzer J, O'Donoghue MW. Outcomes of phacoemulsification in patients with and without pseudoexfoliation syndrome. J Cataract Refract Surg. 2003; 29:1080−1086. DOI: 10.1016/S0886-3350(02)01993-4.

8. Damji KF, Konstas AG, Liebmann JM, Hodge WG, Ziakas NG, Giannikakis S, et al. Intraocular pressure following phacoemulsification in patients with and without exfoliation syndrome: a 2-year prospective study. Br J Ophthalmol. 2006; 90: 1014−1018. DOI: 10.1136/bjo.2006.091447.

9. Cimetta DJ, Cimetta AC. Intraocular pressure changes after clear corneal phacoemulsification in nonglaucomatous pseudoexfoliation syndrome. Eur J Ophthalmol. 2008; 18:77−81. DOI: 10.1177/112067210801800113.

10. Wirbelauer C, Anders N, Pham DT, Wollensak J, Laqua H. Intraocular pressure in nonglaucomatous eyes with pseudoexfoliation syndrome after cataract surgery. Ophthalmic Surg Lasers. 1998; 29: 466−471. DOI: 10.3928/1542-8877-19980601-06.

11. Pohjalainen T, Vesti E, Uusitalo RJ, Laatikainen L. Intraocular pressure after phacoemulsification and intraocular lens implantation in nonglaucomatous eyes with and without exfoliation. J Cataract Refract Surg. 2001; 27:426−431. DOI: 10.1016/S0886-3350(00)00691-X.

12. Altan-Yaycioglu R, Canan H, Pelit A, Akova YA. Intraocular pressure after phacoemulsification in eyes with pseudoexfoliation. J Cataract Refract Surg. 2009; 35: 952−954. DOI: 10.1016/j.jcrs.2009.01.015.

13. Rustam N, Waseem M, Hussain I. Cataract surgery; intraocular pressure in non-glaucomatous eyes with pseudoexfoliation syndrome. Professional Medical Journal 2006; 13: 225−230. Accessed 1 March 2018.
Available: http://www.pakmedinet.com/9708.

14. Gür Güngör S, Akman A, Asena L, Aksoy M, Sarıgül Sezenöz A. Changes in Anterior Chamber Depth after Phacoemulsification in Pseudoexfoliative Eyes and their Effect on Accuracy of Intraocular Lens Power Calculation. Turkish Journal of Ophthalmology 2016; 46: 255−258. DOI: 10.4274/tjo.56659.

15.Moghimi S, Johari M, Mahmoudi A, et al.Predictors of intraocular pressure change after phacoemulsification in patients with pseudoexfoliation syndrome. Br J Ophthalmol. 2017;101:283-289. DOI: 10.1136/bjophthalmol-2016-308601

16. Kondo T, Yamauchi T, Nakatsu A. Effect of cataract surgery on aqueous turnover and blood-aqueous barrier. J Cataract Refract Surg. 1995; 21:706−709. DOI: 10.1016/S0886-3350(13)80571-8.

17. Abdel-Latif AA. Release and effects of prostaglandins in ocular tissues. Prostaglandins Leukot Essent Fatty Acids 1991; 44: 71−82. DOI: 10.1016/0952-3278(91)90186-9.

18. Oshika T, Yoshimura K, Miyata N. Postsurgical inflammation after phacoemulsification and extracapsular extraction with soft or conventional intraocular lens implantation. J Cataract Refract Surg. 1992;18: 356−361. DOI: 10.1016/S0886-3350(13)80071-5.

19. Schumacher S, Nguyen NX, Küchle M, Naumann GO. Quantification of aqueous flare after phacoemulsification with intraocular lens implantation in eyes with pseudoexfoliation syndrome. Arch Ophthalmol. 1999; 117: 733−735. DOI: 10.1001/archopht.117.6.733.

20. Jacobi PC, Krieglstein GK. Trabecular aspiration: a new surgical approach to improve trabecular facility in pseudoexfoliation glaucoma. Int Ophthalmol. 1994; 18: 153−157. DOI: 10.1007/BF00915964.

21. Jacobi PC, Dietlein TS, Krieglstein GK. Bimanual trabecular aspiration in pseudoexfoliation glaucoma: an alternative in nonfiltering glaucoma surgery. Ophthalmology 1998;105(5):886-894. DOI: 10.1016/S0161-6420(98)95032-1.

22. Saccà S, Marletta A, Pascotto A, Barabino S, Rolando M, Giannetti R et al. Daily tonometric curves after cataract surgery.Br J Ophthalmol. 2001; 85: 24-29. DOI: 10.1136/bjo.85.1.24.

23. Suzuki R, Tanaka K, Sagara T, Fujiwara N. Reduction of intraocular pressure after phacoemulsification and aspiration with intraocular lens implantation. Ophthalmologica 1994; 208(5):254-8. DOI: 10.1159/000310502.