• Clinical Research •

Effect of phacoemulsification on intraocular pressure in patients with primary open angle glaucoma and pseudoexfoliation glaucoma

Jesus Jimenez-Roman[1], Gabriel Lazcano-Gomez[1], Karina Martínez-Baez[1], Mauricio Turati[1], Rosario Gulías-Cañizo[2,3], Luis F. Hernández-Zimbrón[2], Lenin Ochoa-De la Paz[2], Rubén Zamora[2], Roberto Gonzalez-Salinas[2]

[1]Glaucoma Department, Asociation to Prevent Blindness in Mexico, Mexico City 04030, Mexico
[2]Research Department, Asociation to Prevent Blindness in Mexico, Mexico City 04030, Mexico
[3]Cell Biology Department, Advanced Research Center, I.P.N. (CINVESTAV) in Mexico City, Mexico City 07360, Mexico
Correspondence to: Roberto Gonzalez-Salinas. Vicente García Torres 46, Barrio San Lucas, Coyoacán, Mexico City 04030, Mexico. dr.gonzalezsalinas@apec.com.mx
Received: 2017-01-14 Accepted: 2017-04-14

Abstract

• AIM: To compare the effect of phacoemulsification on intraocular pressure (IOP) in patients with primary open angle glaucoma (POAG) and pseudoexfoliation glaucoma (PXG).

• METHODS: A retrospective comparative case series conducted at the Glaucoma Department at the Association to Prevent Blindness in Mexico. The study enrolled consecutive patients having phacoemulsification with intraocular lens (IOL) implantation and a diagnosis of POAG or PXG. Data about IOP values and number of glaucoma medications used was collected at baseline, 1, 3, 6 and 12mo postoperatively.

• RESULTS: The study enrolled 88 patients (88 eyes). After phacoemulsification, there was a statistically significant reduction in IOP values and glaucoma medications use compared to baseline in both POAG and PXG patients (*P*<0.001). In the POAG group, a 20% decrease in IOP values was evidenced, and a 56.5% reduction in the number of medications used at the one-year follow-up. The PXG group showed a 20.39%, and a 34.46% decrease in IOP and number of medications used, respectively. A significant difference in the mean ΔIOP (postoperative changes in IOP) was evidenced between groups (*P*=0.005). The reduction of the postsurgical IOP mean values in both groups, the POAG group showed a greater reduction in IOP values compared to the PXG group.

• CONCLUSION: In both types of glaucoma, phacoemulsification cataract surgery can result in a significant IOP reduction (20%) over a 12mo follow-up period. The number of medications used is also significantly reduced up to 12mo after surgery, especially in the PXG group.

• KEYWORDS: cataract surgery; pseudoexfoliation glaucoma; secondary glaucoma; primary open angle glaucoma; intraocular pressure

DOI:10.18240/ijo.2017.09.07

Citation: Jimenez-Roman J, Lazcano-Gomez G, Martínez-Baez K, Turati M, Gulías-Cañizo R, Hernández-Zimbron LF, Ochoa-De la Paz L, Zamora R, Gonzalez-Salinas R. Effect of phacoemulsification on intraocular pressure in patients with primary open angle glaucoma and pseudoexfoliation glaucoma. *Int J Ophthalmol* 2017;10(9): 1374-1378

INTRODUCTION

Pseudoexfoliation (PXF) syndrome is a systemic disorder of unknown etiology with the potential for many intraocular complications[1]. PXF is an age-related disorder characterized by the production and accumulation of an abnormal PXF fibrillar material in various ocular tissues[2]. PXF material accumulations mechanically weaken the zonular lamellae and impair zonular anchoring to the ciliary epithelial basement membrane at both its origin and insertion[3]. In addition, previous studies have demonstrated that higher cataract grade and shallower preoperative anterior chamber are key risk factors for endothelial cells reduction after cataract surgery in eyes with PXF[3-7]. Although the prevalence described varies between series in different countries and specific populations[1,8], it has been reported this syndrome affects about 0.2%-30% of people older than 60y worldwide[8]. PXF remains an important risk factor related to ocular complications during cataract surgery due to its association with high intraocular pressure (IOP), reduced pupil dilation and zonular weakness[9-10]. Pseudoexfoliation glaucoma (PXG) is the most common form of secondary open angle glaucoma and develops in the context of PXF[11-12]. Glaucoma

frequently occurs in eyes with PXF syndrome and compared to primary open angle glaucoma (POAG), optic damage is more pronounced in these eyes at the time of diagnosis, and response to medical therapy is poorer[13].

Previous series have demonstrated that postoperative IOP is directly related with preoperative IOP values[14-15]: the higher the preoperative IOP, the greater the postoperative IOP reduction[15-16]. In addition, recent studies on controlled POAG patients have demonstrated a modest decrease in IOP after undergoing phacoemulsification surgery[17]. However, it has been suggested that changes in IOP after cataract surgery can be different among glaucoma types and ethnic groups[17-18]. POAG and PXG are the most common types of chronic open angle glaucoma worldwide[6]; and it has been described that uncomplicated phacoemulsification with posterior chamber intraocular lens (IOL) implantation surgery alone lowers IOP and reduces their need for anti-glaucomatous drugs[3-4].

The purpose of this study was to determine long-term reduction in IOP and glaucoma medications use after routine cataract phacoemulsification surgery in patients with PXG in comparison to those with POAG.

SUBJECTS AND METHODS

Study Design This retrospective, observational and comparative study was approved by the Internal Review Board of the Association to Prevent Blindness in Mexico. All the procedures conformed to the tenets of the Declaration of Helsinki. All participants signed a written informed consent before surgical procedures were performed.

Patients The medical records of patients with a diagnosis of POAG or PXG that underwent phacoemulsification cataract surgery from January 2014 to January 2016 at the Glaucoma Department of the Association to Prevent Blindness in Mexico were analyzed.

Data collected from records included: age, gender, IOP at all time intervals, and medication used. This analysis comprised eyes of consecutive patients that had routine phacoemulsification surgery. Eligibility criteria included: age ≥50y, diagnosis of POAG or exfoliative glaucoma (XFG) in the presence of a cataract that decreased visual acuity and evidence of glaucomatous optic nerve changes and/or visual field defects related to glaucoma damage, with an IOP of ≤25 mm Hg. All patients were diagnosed with glaucoma using functional and/or structural studies. Functional studies included 24-2 visual fields (Humphrey© Field Analyzer 750i, Carl Zeiss, Germany). In addition, optical coherence tomography (Cirrus© HD OCT, Carl Zeiss, Germany) was employed for structural analysis.

All eyes were examined before surgery, including a complete slit-lamp evaluation under pharmacological pupil dilation. Exclusion criteria included: ocular history of any laser procedure or incisional surgery; history of acute IOP elevation; IOP >25 mm Hg and inability to complete study procedures.

Two IOP measurements were obtained for each eye by the same ophthalmologist between 9:00 a.m. and 12:00 a.m. during preoperative and postoperative visits. From the two IOP measurements, a mean IOP value was derived for statistical analysis. If the two IOP values differed by more than 2 mm Hg, the ophthalmologist would perform a third IOP measurement, and the median value was utilized in the statistical analysis.

Table 1 Patient demographics *n* (%)

Characteristics	POAG group	PXG group	95%CI	*P*[1]
Eyes	44	44	-	-
Male	18 (40.91)	17 (38.64)	-	-
Female	26 (59.09)	27 (61.36)	-	-
Age (a)±SD	77.59±7.54	75.86±7.79	-6.00, 2.00	0.292

[1]Wilcoxon matched-pairs signed rank test. SD: Standard deviation.

Surgical Technique A standard Stop&Chop technique using topical anesthesia was performed in all cases. Clear corneal incisions of 2.8 mm were made and manually created capsulorhexes of 5.0 to 5.5 mm were utilized for all surgeries. The same ophthalmic viscosurgical device (OVD) Duovisc® (sodium hyaluronate 3%-chondroitin sulfate 4.0% with sodium hyaluronate 1.0%; Alcon Laboratories, Inc. Fort Worth, Texas, USA) was utilized in all surgical procedures. Fluid parameters were set as follows: vacuum limit 350, aspiration flow rate 40 mL/min. Ultrasound power was set according to the lens density of each patient. After cataract removal and aspiration of cortical material, the appropriate IOL was implanted in the capsular bag, removing the remaining OVD from the anterior chamber; finalizing the surgical procedure.

Statistical Analysis Given an α of 0.05, a β of 0.20, a standard deviation of 1.00, and a power of 0.80, the estimated study sample size was 43.5 per group. The statistical significance of changes in IOP was determined by a Wilcoxon match-pairs signed rank test. The comparison among time intervals was assessed by the Kruskal-Wallis test. In addition, a Dunn multiple comparison test was used to compare the preoperative IOP measurements with postoperative time intervals. A *P* value less than 0.05 was considered statistically significant. Normal and non-normal distributions were determined by Shapiro-Wilk tests for all variables. Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) software (version 20, SPSS, Inc., Chicago, IL, USA). Graphs and layouts depicted in Figures were elaborated using the 2015 GraphPad software Inc. Prism version 6.0.

RESULTS

A total of 88 patients were enrolled in the study, 44 per group. Clinical and demographic data are summarized on Table 1.

Figure 1 depicts the effect of phacoemulsification cataract surgery on the mean IOP at each time interval. There was a statistically significant reduction in IOP compared to preoperative values at all time intervals from 1 to 12mo postoperatively. In the POAG group, IOP diminished compared to baseline at all time points (Table 2).

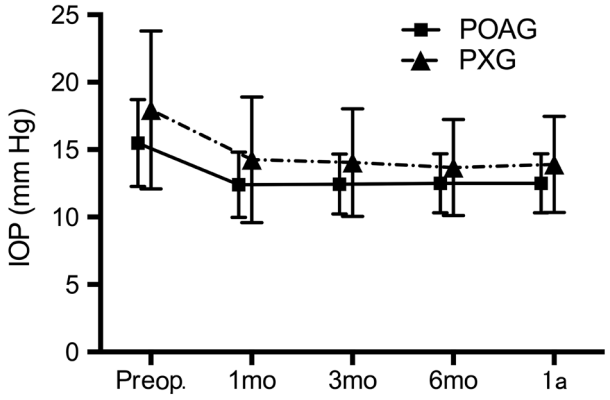

Figure 1 IOP values comparison between groups A statistically significant reduction in mean IOP over preoperative values at all postoperative time intervals (Kruskal-Wallis test; P<0.0001).

Table 2 Multiple comparison test between preoperative values and postoperative time intervals

IOP intervals	Rank sum	P[1]
Preop. *vs* 1mo	29.50	No
Preop. *vs* 3mo	38.00	Yes
Preop. *vs* 6mo	37.50	Yes
Preop. *vs* 1a	37.50	Yes

[1]Dunn's multiple comparison test (P<0.05).

The decrease was significantly greater than in the PXG group at 3, 6 and 12mo postoperatively. A significant difference in the mean ΔIOP was evidenced between groups as shown in Table 3.

In the PXG group the mean IOP before surgery was 17.9 mm Hg with a mean of 2.06 medications used, which decreased to a mean of 14.25 mm Hg postoperatively with a mean of 1.35 medications used after 12mo of follow-up, which represents a 20.3%, and a 34.46% decrease in IOP and number of medications used, respectively.

The mean IOP before surgery in the POAG group was 15.9 mm Hg with a mean of 2.3 medications used, which decreased to 13.1 mm Hg with a mean of 1.1 medications used during the 12mo follow-up. This represents a 20.0% decrease in IOP, and a 56.5% reduction in the number of medications used.

Preoperatively, 34 patients in the PXG group required glaucoma medications. During the 12mo follow-up, the number of medications used diminished in all patients and also 10 patients discontinued medication use due to IOP decrease. No patient required additional glaucoma medications postoperatively.

DISCUSSION

In our study, the mean postoperative IOP at 12mo was significantly lower than the respective preoperative values. Moreover, the mean ΔIOP difference was also statistically significant between groups (P<0.0001). This difference suggests that despite the reduction of the postsurgical IOP mean values in both groups, the POAG group showed a greater reduction in IOP values compared to the PXG group. Our findings agree with previous studies that documented an improvement in glaucoma control after phacoemulsification. Mierzejewski *et al*[19], reported in PXG patients, a decrease in IOP from 20.6 to 15.1 mm Hg (a 27% reduction; P<0.00001). In addition, the number of medications used decreased from 1.7 to 1.2, similar to our results[12]. Also reported a 5% increase in postoperative IOP, but the glaucoma severity was not reported and therefore poorly controlled patients may have minor improvements postoperatively.

Other series have demonstrated a greater IOP reduction postoperatively in elderly patients, females, eyes with an axial length ≤21 mm, and PXF patients[17-18,20]. However, it has been described that in patients with certain types of glaucoma, mean IOP may be reduced up to 5.5 mm Hg[16,18]. A recent Meta-analysis evaluated the impact of phacoemulsification on IOP in glaucoma patients, which reported that in POAG patients who are controlled with 1 or 2 medications, phacoemulsification alone results in a modest decrease in IOP (13%) as well as in medication use (12%)[17]. Furthermore, this analysis reported that incisional glaucoma surgery would be rarely necessary for IOP control within 1y[17-18]. In patients with mild to moderate PXG controlled with 1 or 2 medications, phacoemulsification results in a moderate decrease in IOP (20%) and in the number of medications required after surgery (35%)[18].

Shingleton *et al*[21] studied 240 eyes, also with medically controlled PXG, in patients who underwent uncomplicated phacoemulsification. The extent of glaucoma damage was not reported. Among 51 eyes with a follow-up of 60mo, the IOP decreased from 18.0 to 16.9 mm Hg (6%; P<0.030), and the number of medications used decreased from a mean of 1.6 to 1.0 (38%), similar to the reduction obtained in the PXG group in our study.

In addition, among studies including PXG and non-PXG patients, Peräsalo[22], retrospectively studied 182 Finnish patients (226 eyes) with medically controlled PXG (n=124) and POAG (n=102) who underwent phacoemulsification cataract surgery. The IOP decreased from 17.1 to15.3 mm Hg (P<0.001) at 12mo of follow-up. The number of medications used decreased from a mean of 1.5 to 0.9 (40%); but 37% of the patients in the study required an increase in medications[22]. This study included PXG and POAG patients, and reported similar reductions both in IOP and in postoperative medication use; however, no significant differences were evidenced between groups. Similarly, Elguin *et al*[3] reported no significant differences in postoperative IOP measurements between PXG and POAG patients undergoing uneventful cataract surgery.

Several studies have shown that the decrease in IOP after phacoemulsification is more pronounced in eyes with a

Table 3 Impact of postoperative IOP on IOP reduction evidenced by ΔIOP for each group postoperative change in IOP mm Hg

Postop. interval	POAG			PXG			[a]*P*
	Eyes (*n*)	Mean±SD	Mean ΔIOP (%)	Eyes (*n*)	Mean±SD	Mean ΔIOP (%)	
1mo	44	13.36±2.21	-2.54 (15.9)	44	14.12±2.91	-3.78 (21.1)	<0.0001
3mo	43	13.26±2.93	-2.64 (16.6)	41	14.07±2.93	-3.83 (21.3)	0.044
6mo	38	13.26±2.16	-2.64 (16.6)	39	14.25±3.03	-3.65 (20.3)	0.015
12mo	38	13.19±2.2	-2.80 (17.6)	35	14.25±3.03	-3.65 (20.3)	0.005

ΔIOP: Postoperative changes in intraocular pressure; SD: Standard deviation. [a]Wilcoxon matched-pairs signed rank test.

higher preoperative IOP[16]. However, few studies have evaluated the postoperative IOP response in patients with PXG compared to those with POAG. It has been suggested that phacoemulsification removes a source of PXF material (the anterior lens capsule) and results in or stimulates clearance of PXF and pigment debris from the anterior segment, in particular the trabecular meshwork[1].

Various IOP reduction mechanisms after phacoemulsification have been proposed, however, the key mechanism may vary across different types of glaucoma[23]. IOP drop following phacoemulsification has been shown to be greater in patients with PXF[17]. In addition, it has been described that IOP response after phacoemulsification surgery in patients with PXF correlated with the volume of irrigation fluid used intraoperatively, thus reinforcing the idea that the procedure may remove exfoliation material from the outflow system[17,24].

This study has some limitations that should be noted, one of the main weaknesses of this study is its retrospective nature with the inherent limitations of data extrapolation, and therefore subject to the selection bias of such a study. In addition, this study examined IOP alone and did not evaluate the status of the optic nerve head, nerve fiber layer, or visual fields in the disease population.

In summary, our findings suggest that inpatients diagnosed with PXG or POAG, controlled with 1 or 2 medications and IOP >25 mm Hg, cataract phacoemulsification surgery results in a significant decrease in IOP, as well as in the number of medications required after surgery. Therefore, early cataract surgery may be considered for the treatment of patients with a visually significant cataract and glaucoma as a reasonable surgical option in patients with coexisting cataract and relatively well-controlled glaucoma.

ACKNOWLEDGEMENTS

We wish to acknowledge the Association to Prevent Blindness in Mexico for the facilities to carry out this study.

Conflicts of Interest: **Jimenez-Roman J**, None; **Lazcano-Gomez G**, None; **Martínez-Baez K**, None; **Turati M**, None; **Gulías-Cañizo R**, None; **Hernández-Zimbrón LF**, None; **Ochoa-De la Paz L**, None; **Zamora R**, None; **Gonzalez-Salinas R**, None.

REFERENCES

1 Merkur A, Damji KF, Mintsioulis G, Hodge WG. Intraocular pressure decrease after phacoemulsification in patients with pseudoexfoliation syndrome. *J Cataract Refract Surg* 2001;27(4):528-532.

2 Ritch R, Schlötzer-Schrehardt U. Exfoliation syndrome. *Surv Ophthalmol* 2001;45(4):265-315.

3 Elgin U, Şen E, Şimşek T, Tekin K, Yılmazbaş P. Early postoperative effects of cataract surgery on anterior segment parameters in primary open-angle glaucoma and pseudoexfoliation glaucoma. *Turk J Ophthalmol* 2016;46(3):95-98.

4 Hasegawa Y, Nejima R, Mori Y, Sakisaka T, Minami K, Miyata K, Oshika T. Risk factors for corneal endothelial cell loss by cataract surgery in eyes with pseudoexfoliation syndrome. *Clin Ophthalmol* 2016;10:1685-1689.

5 Shingleton BJ, Neo YN, Cvintal V, Shaikh AM, Liberman P, O'Donoghue MW. Outcome of phacoemulsification and intraocular lens implantion in eyes with pseudoexfoliation and weak zonules. *Acta Ophthalmol* 2017;95(2):182-187.

6 Tarkkanen AH, Kivelä TT. Comparison of primary open-angle glaucoma and exfoliation glaucoma at diagnosis. *Eur J Ophthalmol* 2015;25(2):137-139.

7 Hayashi K, Manabe S, Yoshimura K, Kondo H. Corneal endothelial damage after cataract surgery in eyes with pseudoexfoliation syndrome. *J Cataract Refract Surg* 2013;39(6):881-887.

8 You QS, Xu L, Wang YX, Yang H, Ma K, Li JJ, Zhang L, Jonas JB. Pseudoexfoliation: normative data and associations: the Beijing eye study 2011. *Ophthalmology* 2013;120(8):1551-1558.

9 Govetto A, Lorente R, Vázquez de Parga P, Rojas L, Moreno C, Lagoa F, Lorente B. Frequency of pseudoexfoliation among patients scheduled for cataract surgery. *J Cataract Refract Surg* 2015;41(6):1224-1231.

10 Shingleton BJ, Rosenberg RB, Teixeira R, O'Donoghue MW. Evaluation of intraocular pressure in the immediate postoperative period after phacoemulsification. *J Cataract Refract Surg* 2007;33(11):1953-1957.

11 Schlötzer-Schrehardt U, Naumann GO. Ocular and systemic pseudoexfoliation syndrome. *Am J Ophthalmol* 2006;141(5):921-937.

12 Álvarez L, García M, González-Iglesias H, Escribano J, Rodríguez-Calvo PP, Fernández-Vega L, Coca-Prados M. LOXL1 gene variants and their association with pseudoexfoliation glaucoma (XFG) in Spanish patients. *BMC Med Genet* 2015;16:72.

13 Drolsum L, Rongvold A, Nicolaissen B. Cataract and glaucoma surgery in pseudoexfoliation syndrome: a review. *Acta Ophthalmol Scand* 2007;85(8):810-821.

14 Hayashi K, Hayashi H, Nakao F, Hayashi F. Changes in anterior chamber angle width and depth after intraocular lens implantation in eyes with glaucoma. *Ophthalmology* 2000;107(4):698-703.

15 Lai JS, Tham CC, Chan JC. The clinical outcomes of cataract extraction by phacoemulsification in eyes with primary angle-closure glaucoma (PACG) and coexisting cataract; a prospective case series. *J Glaucoma* 2006;15(1):47-52.

16 Mathalone N, Hyams M, Neiman S, Buckman G, Hod Y, Geyer O. Long-term intraocular pressure control after clear corneal phacoemulsification in glaucoma patients. *J Cataract Refract Surg* 2005; 31(3):479-483.

17 Chen PP, Lin SC, Junk AK, Radhakrishnan S, Singh K, Chen TC. The effect of phacoemulsification on intraocular pressure in glaucoma patients: a report by the American Academy of Ophthalmology. *Ophthalmology* 2015;122(7):1294-1307.

18 Guan H, Mick A, Porco T, Dolan BJ. Preoperative factors associated with IOP reduction after cataract surgery. *Optom Vis Sci* 2013;90(2):179-184.

19 Mierzejewski A, Eliks I, Kaluzny B, Zygulska M, Harasimowicz B, Kaluzny JJ. Cataract phacoemulsification and intraocular pressure in glaucoma patients. *Klin Oczna* 2008;110(1-3):11-17.

20 Zetterström C, Behndig A, Kugelberg M, Montan P, Lundström M. Changes in intraocular pressure after cataract surgery: analysis of the Swedish national cataract register data. *J Cataract Refract Surg* 2015;41(8):1725-1729.

21 Shingleton BJ, Laul A, Nagao K, Wolff B, O'DonoghueM, Eagan E, Flattem N, Desai-Bartoli S. Effect of phacoemulsification on intraocular pressure in eyes with pseudoexfoliation: single-surgeon series. *J Cataract Refract Surg* 2008;34(11):1834-1841.

22 Peräsalo R. Phaco-emulsification of cataract in eyes with glaucoma. *Acta Ophthalmol Scand* 1997;75(3):299-300.

23 Moghimi S, Johari M, Mahmoudi A, Chen R, Mazloumi M, He M, Lin SC. Predictors of intraocular pressure change after phacoemulsification in patients with pseudoexfoliation syndrome. *Br J Ophthalmol* 2017;101(3): 283-289.

24 Damji KF, Konstas AG, Liebmann JM, Hodge WG, Ziakas NG, Giannikakis S, Mintsioulis G, Merkur A, Pan Y, Ritch R. Intraocular pressure following phacoemulsification in patients with and without exfoliation syndrome: a 2 year prospective study. *Br J Ophthalmol* 2006; 90(8):1014-1018.