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Research Article

Intraocular Lens Power Calculation Predictability Following Acute Primary Angle-Closure Glaucoma

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Abstract

Purpose: To assess the effect of previously controlled angle-closure glaucomatous attack on the IOL power calculation and post-operative refraction using the predictive error comparison between study groups.

Design: Retrospective observational case series.

Methods: We included 21 eyes of 18 patients (3 males and 15 females) with their ages 75.11 ± 8.6 had phaco-emulsification with intraocular lens implantation procedure after past medically controlled primary angle-closure glaucoma attack.

Intraocular lens power was calculated using IOL Master™ (Carl Zeiss Jena, Germany), using the axial length of the diseased (ipsilateral) eye with previous glaucoma attack as control group; the keratometric readings were divided into 2 groups: the ipsilateral eye and contra-lateral eye.

The predictive error as spherical equivalent was calculated and compared using Wilcoxon signed-rank test (both raw and absolute data), also we compared percentage of eyes within 0.5 and 1.0 D using Fisher Exact test.

Results: The absolute predictive error was for the ipsilateral eye group 0.43 ± 0.41D and 0.39 ±0.35 D for the contra-lateral eye group which was also statistically non-significant, P-value 0.39 (Wilcoxon signed-rank test).

The percentage of cases within 1.0 D was 83.3% for the same eye group and 100% for the contra-lateral eye group with the P-value equal 0.22 (Fisher Exact test).

Conclusion: Calculating the IOL power in eyes after controlled ACG attack using the K-readings of the contralateral eye may have lower predictive error and better post-operative refractive outcomes.

Keywords: *Primary Angle-closure Glaucoma (PACG); Intraocular Lens (IOL) Power; Predictability; Target Refraction; Predictive Error*

Introduction

Primary angle-closure glaucoma is a major cause of blindness worldwide, a disease caused by distorted ocular anatomy related to pupillary block and angle-crowding mechanisms that lead to anterior chamber filtration angle closure. Those more vulnerable to primary angle-closure including small eyes with short axial length, shallow anterior chamber, and reduced filtration angle width, with a proportionately large thick crystalline lens. Lens removal procedures dramatically widen the filtration angle and relieve the causative pupillary block. Lensectomy with posterior chamber intraocular lens implantation as a treatment strategy for acute, chronic, and secondary angle-closure glaucoma shows favorable results [1].

Cataract surgery alone or combined with trabeculectomy should be considered in the treatment of angle closure glaucoma. However, in eyes with open angle glaucoma, cataract surgery alone may be of limited clinical benefit in lowering IOP and an additional anti-glaucoma procedure may be added [2].

Recent advances in techniques and technology of phacoemulsification and intraocular lenses together with the popularity of cataract surgery procedure made it the most commonly performed ophthalmic procedure with high predictability of visual and refractive outcome [3].

Visual improvement and intraocular pressure reduction secondary to crystalline lens removal encouraged ophthalmologists to treat some types of glaucoma by lens extraction alone either as a definite treatment or as a preliminary step in the management plan that can be followed later by other glaucoma surgical intervention when needed [4].

Patients and Methods

Study population

We included 21 eyes of 18 patients (3 males and 15 females) with their ages 75.11 ± 8.6 had phaco-emulsification with intraocular lens implantation procedure after past glaucomatous attack being controlled by medical measures. The study followed the tenets of the Declaration of Helsinki. Informed consent was not obtained for this retrospective observational case series. Patients included for the study were those had past acute attack of angle-closure glaucoma and controlled with medical measures within 1 - 3 months duration prior to cataract surgery. We excluded patients with types of glaucoma other than the primary angle-closure type, significant glaucomatous changes, absolute eyes, advanced glaucomatous optic atrophy, coexisting ocular pathologies anticipated to affect the visual outcome or previous ocular surgeries distorting the ocular contour of the diseased eye and hence the axial length measurement such as buckling surgery for retinal detachment

Target refraction and keratometric readings were calculated by IOL Master using the axial length of the diseased eye (with previous glaucoma attack) as control group and the keratometric readings were divided into 2 groups: the ipsilateral (same) eye and the contralateral eye.

Patients' demographic data are shown in table 1.

Parameter	Value (Mean ± SD)
Number of eyes / patients	21/18
Age (years)	72.1 ± 10.2
Gender (Female %)	83.3% (15 M/3 F)
Spherical equivalent (D)	4.4 ± 7.3
Mean K-readings of the ipsilateral eye (D)	44.57 ± 1.12
Mean K-readings of the contralateral eye (D)	44.77 ± 1.12

Table 1: *Demographic data of the study population divided into 2 groups; group-1 using the K-readings of the ipsilateral eye and group-2 using the K-readings of the contralateral eye for the intraocular lens power calculation.*

Then the predictive error (difference between the target and post-op. actual refraction as spherical equivalent) was calculated and compared using Wilcoxon signed-rank test (both raw and absolute data), also comparing proportion of cases within 0.5 and 1.0 D using Fisher Exact test.

Surgical procedure

A standard phacoemulsification technique was done for patients after appropriate medical control of the acute angle-closure attack, surgery was done in classic steps consisted of a 2.8 mm clear corneal incision, anterior continuous curvilinear capsulorrhexis, nucleus emulsification and irrigation-aspiration of the cortex followed by implantation of an acrylic intra-ocular lens and hydration of the corneal incision. Postoperatively, topical antibiotic and steroid were administered topically 4 times daily for 1 month, after which the dose was gradually tapered.

Statistical analysis

All statistical analyses were performed using StatView software (version 5.0, SAS Institute, Inc.). Wilcoxon signed-rank test was used to compare both raw and absolute predictive error values between the study groups. The proportion of eyes within 0.5 and 1.0 D were compared using Fisher Exact test. A *P*- value less than 0.05 was considered statistically significant.

Results

The mean keratometric readings of the ipsilateral eye group 44.81 D ± 1.13 (Mean ± SD) and 44.82 D ± 1.20 in the contra-lateral eye group (Shown in table 1 of patients' demographic data).

To detect accuracy of IOL power measurement, the predictive error which is the difference between the preoperative targeted and the actual post-operative refraction as spherical equivalent was calculated and compared using Wilcoxon signed-rank test (both raw and absolute data), also we compared percentage of eyes within 0.5 and 1.0 D using Fisher Exact test.

The predictive errors for the ipsilateral eye group was 0.29 ± 0.52 D and from the contra-lateral eye group 0.25 ± 0.46 D, we found no statistical significance between both groups, *P*-value 0.60 (Wilcoxon signed-rank test).

The absolute predictive error was for the ipsilateral eye group 0.43 ± 0.41D and 0.39 ±0.35 D for the contra-lateral eye group which was also statistically non-significant, *P*-value 0.39 (Wilcoxon signed-rank test).

The mean raw and absolute predictive error were compared between study groups postoperatively and shown in table 2.

Study group	Group-1	Group-2	P-value
PE (Mean ± SD)	0.29 ± 0.52	0.25 ± 0.46	0.60
APE (Mean ± SD)	0.43 ± 0.41	0.39 ± 0.35	0.39

Table 2: *Predictive and absolute predictive error comparison between both study groups.*
PE: Predictive Error; APE: Absolute Predictive Error.

The percentage of cases within 0.5 D was 66.7% for the ipsilateral eye group and 72.2% for the contra-lateral eye with P-value 1.0 (Fisher Exact test).

While the percentage of cases within 1.0 D was 83.3% for the ipsilateral eye group and 100% for the contra-lateral eye with P-value 0.22 (Fisher Exact test).

Comparison of the percentage of eyes within ± 0.5 D and ± 1.0 D postoperatively are shown in table 3.

Study group	Group-1	Group-2	P-value
% eyes within ± 0.5 D	66.67%	72.22%	1.0
% eyes within ± 1.0 D	83.33%	100.00%	0.22

Table 3: *Percentage of eye within o.5 and 1.0 diopter spherical equivalent postoperative refraction comparison between both study groups.*
%: Percentage.

Discussion

Phacoemulsification alone results in variable reduction of IOP and medications required for patients with primary open-angle, primary angle-closure and pseudoexfoliation glaucomas, respectively, and using 1 to 2 anti-glaucoma medications before surgery. Trabeculectomy was found to be rarely required in such patients within 6 to 24 months after phacoemulsification [5].

Earlier study reported that cataract surgery with PC-IOL implantation should be considered in both controlled and uncontrolled PACG coexisting with cataract, instead of filtering surgery or combined procedures. Even in eyes with relatively good visual acuity, cataract extraction alone might be considered as a means of achieving glaucoma control. The best results were obtained in patients with acute PACG (55% IOP reduction) and in patients with uncontrolled PACG (44% IOP reduction). In the other PACG groups an IOP reduction between 20 and 33% was achieved [6].

Intraocular lens power is determined by preoperative biometric data (axial length, keratometric value, anterior chamber depth and lens thickness), the IOL calculation formula, and the IOL constant [7]. Also preoperative anterior chamber depth (ACD) and crystalline lens thickness are taken into consideration in lens power calculation formulas [8].

A study using the Pentacam rotating Scheimpflug camera concluded that quantifying changes in the anterior chamber volume, depth and angle measurements following uneventful phacoemulsification surgery in normotensive eyes with open iridocorneal angles revealed increased anterior chamber depth and volume together with postoperative anterior chamber angle widening in all quadrants 3 months after uneventful phacoemulsification and IOL implantation. These changes are accompanied by a significant fall in IOP in the short term follow-up period [9].

Cataract surgery resulted in not only complete dissolution of lens volume and pupillary block which are the main patho-physiologic factors in cases of acute angle-closure glaucoma, but also attenuation of the forward positioning of the ciliary processes, all of which contributed to postoperative widening of the angle in eyes with primary angle closure [10].

The mean and absolute mean biometry prediction error of the 25 eyes that received phacotrabeculectomy (+0.20 D, absolute error 0.96 D) was comparable to the 70 eyes that received phacoemulsification (-0.14 D, absolute error 0.68 D), P = 0.18 (absolute error, P = 0.12). The proportion of cases with prediction error > 0.50 D or 1.00 D was 60% or 40% for phaco-trabeculectomy, and 44% or 17% for phacoemulsification, respectively. Myopically shifted prediction error was significantly more frequent following posterior chamber intraocular lens implantation with phaco-trabeculectomy compared with phacoemulsification, even when surgery was uncomplicated and performed by the same surgeon [11].

Some studies have surmised that the IOP lowering effect of cataract surgery also induces a decrease in axial length. This suggests the need for a precise investigation of intraocular lens power calculation formula in eyes with angle closure glaucoma. In ACG patients, anterior chamber depth and axial length were shorter and the lens was thicker than normal controls (all $p < 0.001$). Even though residual SE refractive error was not significantly different ($p = 0.29$), the absolute value of the difference between predicted and residual SE refractive error was 0.64 +/- 0.50 diopters in AGC patients and 0.39 +/- 0.36 diopters in control subjects ($p = 0.012$). The number of eyes that resulted in inaccurate IOL power predictions of more than 0.5 diopters were 21 (50.00%) in the ACG group, but only 12 (26.67%) in the control group ($p = 0.043$) [12].

Conclusion

In conclusion, visual and refractive outcomes after cataract surgery in eyes with previously controlled acute attack of PACG is affected by ocular biometric parameters which are used to calculate the intraocular lens power to be implanted. Those biometric parameters;

namely the axial length and keratometric readings, are affected to variable degree as a part of the glaucomatous pathological process and medications used in treatment. Such eyes usually have shorter axial length and flat corneas that necessitate the use of adequate of proper IOL power calculation formula and adequate measurement of the biometric parameters. Limitations of our current study are, the relatively small sample size, the uncontrolled non-randomized design and the relatively short follow-up time of the stability of refractive outcome; hence a larger sample with a control group are recommended to be included in future studies for a longer time of follow-up, also there could be included data comparison obtained by different IOL power calculation formulae.

What was known

- In ACG patients, anterior chamber depth and axial length were shorter and the lens was thicker than normal controls.
- Inaccurate IOL power calculations and lower predictability are commonly encountered in cases suffering from ACG and undergo cataract surgery.

What this paper adds

- Adequate measurement of the axial length together with using the proper IOL power calculation formula enhance better post-operative predictability.
- Using the keratometric readings of the contralateral eye together with the axial length from the ipsilateral eye (with the past glaucoma attack) could improve the refractive outcome and postoperative predictability.

Disclosure

Authors have no financial or propriety interest in the product or method or material described in the current article.

Bibliography

1. Tarongoy P., *et al*. “Angle-closure glaucoma: the role of lens in the pathogenesis, prevention, and treatment”. *Survey of Ophthalmology* 54.2 (2009): 211-225.

2. Vizzeri G and Weinreb RN. “Cataract surgery and glaucoma”. *Current Opinion in Ophthalmology* 21.1 (2010): 20-24.

3. Resnikoff S., *et al*. “Global data on visual impairment on the year 2002”. *Bulletin of the World Health Organization* 82.11 (2004): 844-851.

4. Cioffi GA., *et al*. “Combined cataract/trabeculectomy”. In: Weinreb RN, Crowson JG editors. Glaucoma Surgery Open Angle Glaucoma. volume 2. Kugler Publications The Hague, The Netherlands. (Consensus Series. Association of International Glaucoma Societies (2005): 65-72.

5. Chen PP., *et al*. “The Effect of Phacoemulsification on Intraocular Pressure in Glaucoma Patients: A Report by the American Academy of Ophthalmology”. *Ophthalmology* 122.7 (2015): 1294-1307.

6. Gunning FP and Greve EL. “Uncontrolled primary angle-closure glaucoma: results of early intercapsular cataract extraction and posterior chamber lens implantation”. *International Ophthalmology* 15.4 (1991): 237-247.

7. Drexler W., *et al*. “Partial coherence interferometry: a novel approach to biometry in cataract surgery”. *American Journal of Ophthalmology* 126.4 (1998): 524-534.

8. Terzi E., *et al*. “Accuracy of modern intraocular lens power calculation formulas in refractive lens exchange for high myopia and high hyperopia”. *Journal of Cataract and Refractive Surgery* 35.7 (2009): 1181-1189.

9. Ucakhan OO., *et al*. “Anterior chamber parameters measured by the Pentacam CES after uneventful phacoemulsification in normotensive eyes”. *Acta Ophthalmologica* 87.5 (2009): 544-548.

10. Nonaka A., *et al*. "Angle widening and alteration of ciliary process configuration after cataract surgery for primary angle closure". *Ophthalmology* 113.3 (2006): 437-441.

11. Chan JCH., *et al*. "Comparison of postoperative refractive outcome in phacotrabeculectomy and phacoemulsification with posterior chamber lens implantation". *Journal of Glaucoma* 15.1 (2006): 26-29.

12. Eid TM., *et al*. "IOL Master for IOL power calculation in phaco-trabeculectomy: evaluation of postoperative prediction error and refractive outcome". *Bulletin of the Ophthalmological Society of Egypt* 100.2 (2007): 215-220.

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