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THE INFLUENCE OF CONCOMITANT GLAUCOMA ON IOL POWER CALCULATION ACCURACY

© D.F. Belov [1], V.P. Nikolaenko [1, 2]

[1] Saint Petersburg State Hospital No. 2, Saint Petersburg, Russia;

[2] Saint Petersburg State University, Saint Petersburg, Russia

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✧ ***Aim.*** To estimate the influence of concomitant glaucoma (including that after surgery) on IOL power calculation accuracy before phacoemulsification. ***Materials and methods.*** 413 patients were included in the study divided in 4 groups: 1st — patients with cataract and no concomitant glaucoma (251 cases); 2nd — patients with cataract and primary open-angle glaucoma (POAG) on medical therapy (103 cases); 3rd — patients with cataract and prior trabeculectomy (42 cases); 4th — patients with cataract and primary angle-closure glaucoma (PACG) on medical therapy (17 cases). In all patients, the IOL power calculation was performed using optical biometry (IOL-Master 500). 1 month after surgery, desired refraction according to Barrett Universal II Formula and real obtained refraction estimated by automatic refractometry (Topcon-8800) were compared. ***Results.*** There was no significant difference between study groups 1–3 in IOL power calculation accuracy (the calculation error was −0.09 ± 0.39 D, −0.08 ± 0.45 D, −0.03 ± 0.49 D, for each group respectively). However, we found a higher myopic shift (−0.47 ± 0.48 D, $p = 0.095$) in the 4th group. ***Conclusion.*** The presence of concomitant POAG on medical therapy, same as earlier trabeculectomy, does not demand any modification of the IOL calculation algorithm. However, in PACG patients we recommend taking −0.5 D lower optical power IOLs to avoid excessive myopic refraction after phacoemulsification.

✧ ***Keywords:*** IOL power calculation; optical biometry; glaucoma.

ВЛИЯНИЕ СОПУТСТВУЮЩЕЙ ГЛАУКОМЫ НА ТОЧНОСТЬ РАСЧЁТА ИНТРАОКУЛЯРНЫХ ЛИНЗ

© Д.Ф. Белов [1], В.П. Николаенко [1, 2]

[1] Санкт-Петербургское государственное бюджетное учреждение здравоохранения «Городская многопрофильная больница № 2», Санкт-Петербург;

[2] Федеральное государственное бюджетное образовательное учреждение высшего образования «Санкт-Петербургский государственный университет», Санкт-Петербург

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✧ ***Цель*** — оценить влияние сопутствующей глаукомы (в том числе, оперированной) на точность расчёта силы интраокулярной линзы (ИОЛ) перед выполнением факоэмульсификации. ***Материалы и методы.*** В исследование вошли 413 пациентов, которые были разделены на четыре группы: 1-я — пациенты с катарактой без сопутствующей глаукомы (251 человек); 2-я — пациенты с катарактой и первичной открытоугольной глаукомой (ПОУГ) на гипотензивной терапии (103 человека); 3-я — пациенты с катарактой после выполненной синустрабекулэктомии (42 человека); 4-я — пациенты с катарактой и первичной закрытоугольной глаукомой (ПЗУГ) на гипотензивной терапии (17 человек). Всем обследуемым производился расчёт ИОЛ с помощью оптической биометрии на аппарате IOL-Master 500. Через 1 мес. сравнивались показатели расчётной рефракции по формуле Barrett Universal II и полученной рефракции по данным авторефрактометра Topcon-8800. ***Результаты.*** В исследуемых 1–3-й группах не было выявлено значимых различий в точности расчёта ИОЛ (ошибка расчёта составила −0,09 ± 0,39 дптр, −0,08 ± 0,45 дптр, −0,03 ± 0,49 дптр для каждой группы соответственно). Однако в 4-й группе был

выявлен больший миопический сдвиг рефракции (−0,47 ± 0,48 дптр, $p = 0,095$). ***Заключение.*** Наличие у пациента с катарактой сопутствующей ПОУГ на гипотензивной терапии, так же как и перенесённая синустрабекулэктомия, не вносит никаких поправок в алгоритм расчёта ИОЛ. Однако у пациентов с ПЗУГ рекомендуется выбирать ИОЛ меньшей оптической силы на 0,5 дптр для того, чтобы избежать чрезмерной миопической рефракции после факоэмульсификации.

✧ ***Ключевые слова:*** расчёт силы интраокулярной линзы (ИОЛ); оптическая биометрия; глаукома.

INTRODUCTION

The accuracy of the intraocular lens (IOL) power calculation has been a relevant topic for ophthalmologists since 1949, when the first artificial lens implantation performed by H. Ridley was overshadowed by a calculation error of 20 diopters.

Currently, the requirements for refractive outcomes of cataract surgery have significantly increased. Thus, in 2009, the deviation from target refraction after phacoemulsification (PE) in the eyes with an intact cornea should not exceed 0.5 diopters in 55% of cases and 1.0 diopters in 85% of cases [3] according to the standards of the British National Health Service, but since 2017, the criterion for PE quality has been the target refraction achievement with an accuracy of ±0.25 diopters in 49.8% of cases, ±0.5 diopters in 80.8% of cases, ±0.75 diopters in 93.7% of cases, and up to ±1.0 diopters in 97.8% of cases [1].

In the times of ultrasound biometry, the main source of inaccuracies in IOL power calculation was the error of the technique itself, associated with corneal compression. T. Olsen [8] reported that the most common errors in IOL power calculation were caused by an incorrect measurement of the anteroposterior axis (APA) of the eye (54% of cases) and an incorrect estimate of the anterior chamber depth (38% of cases), whereas keratometric errors affected the accuracy of the lens power calculation to a much lesser extent (8% of cases) [8]. Presently, ultrasonic techniques to estimate the APA are rarely applied (only in the dense cataract cases), and optical biometry has become the method of choice, which is devoid of the above-mentioned errors [13].

With the introduction of noncontact methods to determine APA, errors in IOL power calculation were mainly caused by an incorrect assessment of the effective lens position in the eye, which depends on a large number of variables determined by the anatomy of the eye anterior segment (anterior chamber depth, keratometric parameters, horizontal diameter of the cornea, and the lens thickness), and also preoperative refraction, the capsulorrhexis size, the vitreous body state, gravity, gender, age, etc. [5–7, 14].

In this regard, biometrics for patients with a nonstandard eye anterior segment should be performed carefully. These are often candidates for PE having concomitant primary closure of the anterior chamber angle or primary angle-closure glaucoma (PACG) and patients who have recently undergone a hypotensive surgery that causes biometric changes in the eye (APA shortening, decrease in the anterior chamber depth, change in the corneal refractive power), fraught with even greater errors in IOL power calculation than in patients without previous antiglaucoma interventions [4, 8]. Moreover, the wrong IOL power choice together with reduced contrast sensitivity characteristic of glaucoma will inevitably degrade patients' quality of life [11].

Given the prevalence of primary glaucoma [approximately 60 million patients worldwide, $^3/_4$ of whom have primary open-angle glaucoma (POAG) and $^1/_4$ have PACG] and based on a small number of studies (4 articles in the PubMed database) on the calculation of IOL power in this type of patients, this issue is extremely relevant for practitioners.

This study aimed to assess the effect of concomitant glaucoma (including operated) on the accuracy of IOL power calculation.

MATERIALS AND METHODS

The study included 413 patients (mean age 76 ± 6 years) after PE with IOL implantation, which were distributed into four groups as follows: Group 1 included patients without concomitant glaucoma (251 patients); Group 2 included patients with POAG who received antihypertensive therapy (103 patients); Group 3 included patients after sinus trabeculectomy (STE) (42 patients); and Group 4 included patients with PACG who received antihypertensive therapy (17 patients).

The IOL power was calculated using optical biometry using an IOLMaster 500 apparatus in all cases. One month after the PE, the calculated (expected) refractive indices using the Barrett

Universal II formula were compared with the refraction obtained according to the Topcon 8800 autorefractometer.

RESULTS AND DISCUSSION

A minor myopic error in calculating the IOL power was noted in all four groups (Table 1); however, in group 4 (with PACG), the amplitude was noticeably larger than in groups 1–3 (-0.47 ± 0.48 diopters vs. -0.09 ± 0.39 diopters, -0.08 ± 0.45 diopters, and -0.03 ± 0.49 diopters, respectively).

Our results correlate with data from M. Pakravan et al. [9], which indicated that previous STE does not significantly affect the accuracy of IOL power calculation. The authors revealed that there were no significant errors in calculating the IOL power after PE even in the presence of pronounced biometric changes 6 months after STE (APA shortening by 0.14 ± 0.15 mm, an increase in the refractive power of the cornea by 0.27 ± 0.47 diopters). The deviation from the target refraction when using the formulas was $+0.14 \pm 0.9$ diopters for Hoffer Q ($p = 0.442$), $+0.16 \pm 0.79$ diopters for Holladay ($p = 0.319$), and $+0.2 \pm 0.71$ diopters for SRK/T ($p = 0.17$) [10].

A. Popa Cherecheanu et al. [12] also revealed a minor but myopic (-0.05 ± 0.36 diopters) IOL power calculation error in patients with previous STE and lens removal compared with a hypermetropic calculation error in the eyes without concomitant glaucoma ($+0.35 \pm 0.75$ diopters).

N. Zhang et al. [15] analyzed the refractive results of PE in groups of patients with cataracts and concomitant glaucoma, receiving drug treatment, and after STE. The authors revealed a hypermetropic error in calculating the IOL power in groups 1 and 2 (+0.23 and +0.40 diopters, respectively) and a minor myopic refraction shift in patients with previous STE (−0.36 diopters).

We did not reveal any significant errors in calculating the IOL power in POAG patients, which indicates an adequate preoperative biometric evaluation of the operated eye and the correct choice of the formula for calculating the optical power of the IOL.

There is a statistically insignificant difference between groups 4 and 1–3, which was expressed in a greater myopic refraction shift in patients with PACG (see Fig. 1).

The major myopic error in IOL power calculation observed in group 4 is obviously caused by the biometric aspects of patients with PACG, which are manifested, first of all, in the shallow anterior chamber and the short APA. However, a more accurate analysis of data requires a larger number of patients with PACG.

The comparative characteristics of the main biometric parameters for calculating the IOL power in the groups under investigation are presented in Table 2.

Table 1 / Таблица 1

Comparison of mean IOL power calculation error in study groups
Сравнение среднего значения ошибки расчёта интраокулярной линцы в исследуемых группах

Group	Number of cases, patients	Average value of the error in calculating the IOL power, diopter
Group 1 (no glaucoma)	251	−0.09 ± 0.39
Group 2 (POAG with drug treatment)	103	−0.08 ± 0.45
Group 3 (after STE)	42	−0.03 ± 0.49
Group 4 (PACG with drug treatment)	17	−0.47 ± 0.48

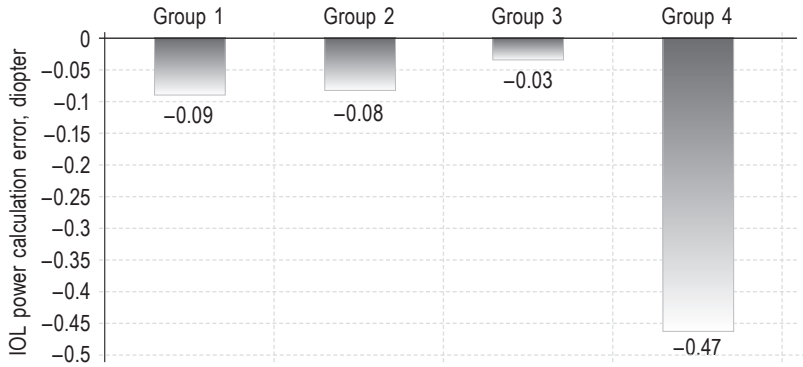
Note. p = 0,095. OL, intraocular lens; POAG, primary open-angle glaucoma; STE, sinus trabeculectomy; PACG, primary angle-closure glaucoma.

Table 2 / Таблица 2

Comparison of mean biometrical parameters in study groups
Сравнение средних значений основных биометрических параметров в исследуемых группах

Group	Keratometry, diopter	APA, mm	Anterior chamber depth, mm
Group 1	43.92 ± 1.29	23.75 ± 1.04	3.00 ± 0.32
Group 2	44.82 ± 1.20	23.35 ± 0.95	2.84 ± 033
Group 3	44.46 ± 1.32	23.71 ± 1.05	2.79 ± 0.30
Group 4	45.02 ± 1.25	22.03 ± 0.76*	2.34 ± 0.14*

Note. * There are statistically significant differences. APA, anteroposterior axis.



Comparison of IOL power calculation in study groups
Сравнение ошибки расчёта интраокулярной линзы в исследуемых группах

CONCLUSION

Requirements for refractive results of cataract surgery are steadily increasing. This fully applies to a fairly large group of patients with cataracts which developed in the presence of glaucoma compensated by drug treatment or surgery.

In our study, no statistically significant differences were found in the results of determining the IOL power of patients with cataracts without concomitant glaucoma, those with cataract and concomitant POAG, those receiving conservative therapy, and those with cataract after STE.

Thus, the presence of concomitant POAG in a patient with cataract who received antihypertensive therapy and previous STE does not introduce any amendments to the IOL power calculation algorithm.

A major myopic error in calculating the IOL power was found in PACG patients, which was probably caused by the shallow anterior chamber, which led to a change in the effective IOL position owing to its anterior shift and the myopic shift. Therefore, it is recommended to revise the power of the selected IOL toward its decrease by 0.5 diopters in excessive myopization after PE when calculating the IOL power with PACG. The conclusion is especially relevant for surgeons operating on Asian patients, among whom the occurrence of PACG is almost four times higher than that of POAG [2].

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Information about the authors

Dmitrii F. Belov — Ophthalmic Surgeon. Microsurgery Department No. 4. City Hospital No. 2, Saint Petersburg, Russia. E-mail: belovd1990@gmail.com.

Vadim P. Nikolaenko — MD, PhD, Professor, Otorhinolaryngology and Ophthalmology Chair of Medical Faculty, Saint Petersburg State University, Saint Petersburg, Russia; Chief, Ophthalmology Department, Saint Petersburg City Hospital No. 2, Saint Petersburg, Russia. E-mail: dr.nikolaenko@mail.ru.

Сведения об авторах

Дмитрий Фёдорович Белов — врач-офтальмолог, отделение микрохирургии глаза № 4. СПбГБУЗ ГМБ № 2, Санкт-Петербург. E-mail: belovd1990@gmail.com.

Вадим Петрович Николаенко — д-р мед. наук, профессор, кафедра оториноларингологии и офтальмологии. ФГБОУ ВО СПбГУ, Санкт-Петербург; заместитель главного врача по офтальмологии. СПбГБУЗ ГМБ № 2, Санкт-Петербург. E-mail: dr.nikolaenko@mail.ru.