

## THE ROLE OF SELF-DEPENDENT TONOMETRY IN IMPROVING DIAGNOSTICS AND TREATMENT OF PATIENTS WITH OPEN ANGLE GLAUCOMA

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*For citation:* Astakhov SY, Farikova EE, Konoplianiuk KA. The role of self-dependent tonometry in improving diagnostics and treatment of patients with open angle glaucoma. *Ophthalmology Journal*. 2019;12(2):41-46. <https://doi.org/10.17816/OV12241-46>

Received: 12.03.2019

Revised: 08.04.2019

Accepted: 21.05.2019

✧ Monitoring intraocular pressure in patients with open-angle glaucoma at different stages of the development of the disease using self-measurement by a portable Icare® HOME tonometer. In study, patients were divided into 3 groups depending on the treatment prescribed. With the help of near-day monitoring, hidden IOP elevations that are not recorded during a single IOP measurement on an outpatient appointment with a doctor were detected. Perspective possibilities of prescribing drugs and regulating the mode of instillation on the basis of individual time periods of increasing intraocular pressure on the example of one of the patient. Assessment of the convenience of the method from the personal experience of using the device by patients.

✧ **Keywords:** open-angle glaucoma; tonometry; Icare® HOME; intraocular pressure; monitoring; diurnal fluctuations of intraocular pressure.

## РОЛЬ САМОСТОЯТЕЛЬНОЙ ТОНОМЕТРИИ В УЛУЧШЕНИИ ДИАГНОСТИКИ И ЛЕЧЕНИЯ БОЛЬНЫХ ОТКРЫТОУГОЛЬНОЙ ГЛАУКОМОЙ

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*Для цитирования:* Астахов С.Ю., Фарикова Э.Э., Конопляник К.А. Роль самостоятельной тонометрии в улучшении диагностики и лечения больных открытоугольной глаукомой // Офтальмологические ведомости. — 2019. — Т. 12. — № 2. — С. 41–46. <https://doi.org/10.17816/OV12241-46>

Поступила: 12.03.2019

Одобрена: 08.04.2019

Принята: 21.05.2019

✧ Осуществлён мониторинг внутриглазного давления у пациентов с открытоугольной глаукомой на разных стадиях развития заболевания с помощью самостоятельных измерений портативным тонометром Icare® HOME. В исследовании пациенты были разделены на три группы в зависимости от назначенного лечения. С помощью околосуточного мониторинга выявлены скрытые подъёмы внутриглазного давления, не регистрируемые при однократном измерении на амбулаторном приёме. Оценены перспективные возможности назначения лекарственных средств и регулирования режима инстилляций исходя из индивидуальных временных отрезков повышения внутриглазного давления на примере одного из пациентов, а также удобства метода по личному опыту использования прибора пациентами.

✧ **Ключевые слова:** открытоугольная глаукома; тонометрия; Icare® HOME; внутриглазное давление; мониторинг; суточные колебания внутриглазного давления.

### INTRODUCTION

Glaucoma is considered to be a progressive optic nerve neuropathy associated with the loss of retinal nerve fibers and the second leading cause of blindness in the world [1, 16]. Reducing the intraocular pressure (IOP) is the only well-accepted effective treatment for glaucoma [2, 3]. Therefore, the mea-

surement of IOP is an important determinant for the effectiveness of treatment, and monitoring of IOP in patients with open-angle glaucoma is necessary [12, 15]. However, despite the fact that IOP remains the only modifiable factor in glaucoma and all treatment methods are aimed at its reduction, IOP is measured only once at a clinic visit dur-

ing a specialist's working hours, and only once a month thereafter [7, 10]. Several ophthalmologists, when measuring IOP during a routine examination, determine the "target pressure," which is based on negative changes identified according to perimetry and OCT of the optic nerve head [9]. Lack of adherence to treatment and late diagnosis are contributing factors to the progression of glaucoma. However, the main reason for the instability of glaucoma progression may be the ignorance of the peak IOP and amplitude of fluctuations during the day [4, 8, 9, 14]. Over the past few decades, special attention has been paid to the role of diurnal fluctuations as an independent risk factor for the progression of glaucoma [5, 11, 13]. Frequent IOP measurement is too labor-consuming, ineffective, and costly for widespread use. A method for studying the circadian rhythm of IOP proposed by Astakhov et al. [6] turned out to be the most effective for detecting the peak values. It covers values that can be obtained beyond the working hours of the outpatient physician. In the present study, we used Icare<sup>®</sup> tonometers (Helsinki, Finland), which are now commonly used and have been correlated with Goldmann applanation tonometry measurements.

## MATERIALS AND METHODS

We enrolled patients aged 23–84 years with open-angle glaucoma. The patients were at different stages of disease progression and were categorized into the following three groups depending on the treatment prescribed:

- 1) patients who received monotherapy with prostaglandin analogues;
- 2) those who received combination therapy;
- 3) those who did not receive therapy.

Group 1 included 15 patients (8 men and 7 women; 29 eyes) with mean age of  $69.7 \pm 8.3$  years. Group 2 included 17 patients (9 men and 8 women; total 32 eyes) with mean age of  $66.2 \pm 14.1$  years. Group 3 included 11 patients (5 men and 6 women; total 21 eyes) with mean age of  $64.5 \pm 15.5$  years. All patients were examined at the Ophthalmology Clinic of the Pavlov State Medical University of Saint Petersburg.

Ophthalmological examination included visual acuity examination, autorefractometry, biomicroscopy (slit lamp Nidek, Japan), indirect ophthalmoscopy using a Volk 60D lens, and gonioscopy using a Goldmann type lens (Olis, Russia). Automated static perimetry (Octopus 101, Haag-Streit International), optical coherence tomography (Heidelberg, Spectralis OCT), and biometry, were performed. In addition,

a single IOP measurement using an Icare<sup>®</sup> TAO1i tonometer with disposable tips was included.

Subsequently, all patients were trained in the tonometry technique using the Icare<sup>®</sup> HOME tonometer for self-monitoring of IOP at home. The patients measured IOP 3 to 5 times a day at different times of the day (from 6:10 to 23:50) for 5 days. Along with the measurement of IOP, the patients recorded their blood pressure values, pulse rate, amount of physical activity, and well-being sense.

At multiple visits, therapy for the patients was adjusted according to obtained measurement results, and a survey was conducted on the convenience of independent use of the Icare<sup>®</sup> HOME tonometer. Furthermore, the patients were asked to indicate the advantages and disadvantages of this diagnostic method.

## RESULTS

At a single outpatient IOP measurement at the clinic, the following average values for OD IOP and OS IOP were obtained: group 1:  $12.9 \pm 3.7$  and  $14.4 \pm 3.8$  mm Hg; group 2:  $12.6 \pm 4.1$  and  $13.4 \pm 4.9$  mm Hg; and group 3:  $16.7 \pm 7.0$  and  $16.4 \pm 6.4$  mm Hg, respectively.

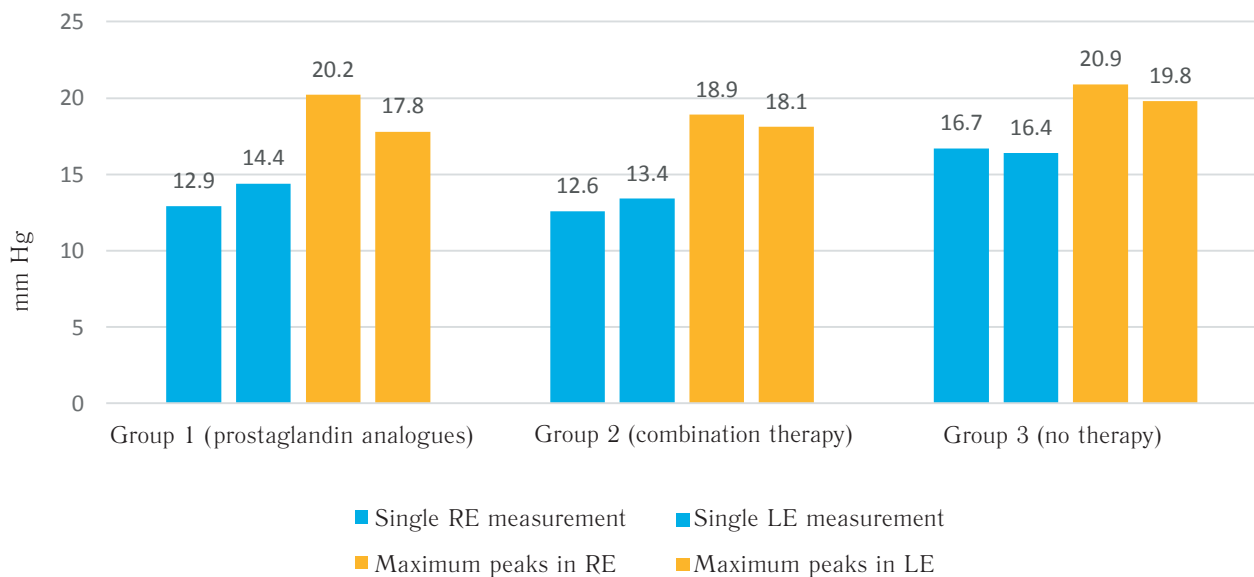
During the circadian monitoring of IOP fluctuations, the peaks of increases, not recorded during a single measurement at a clinic, were  $20.2 \pm 7.4$  and  $17.8 \pm 4.2$  mm Hg in group 1,  $18.9 \pm 4.1$  and  $18.1 \pm 4.3$  mm Hg in group 2, and  $20.9 \pm 7.2$  and  $19.8 \pm 6.4$  mm Hg in group 3 for OD IOP and OS IOP, respectively. A comparison of peaks with results of single measurements in different groups is presented in Figure 1.

Daily fluctuations in RE IOP and LE IOP in patients of group 1 were  $11.6 \pm 6.9$  and  $10.3 \pm 2.6$  mm Hg, those of group 2 were  $11.2 \pm 3.9$  and  $10.0 \pm 4.0$  mm Hg, and those of group 3 were  $11.2 \pm 4.0$  and  $10.4 \pm 4.6$  mm Hg, respectively.

To assess the convenience of using the device, the patients responded to a questionnaire with answers on a scale of 1 to 5. They were required to answer the questions regarding personal experience with the use of Icare<sup>®</sup> HOME device. The averaged survey results are presented in Figure 2. Patients indicated advantages of using the device such as ease of use and speed of measurement, whereas the disadvantages included difficulty in correctly positioning the sensor relative to the eye.

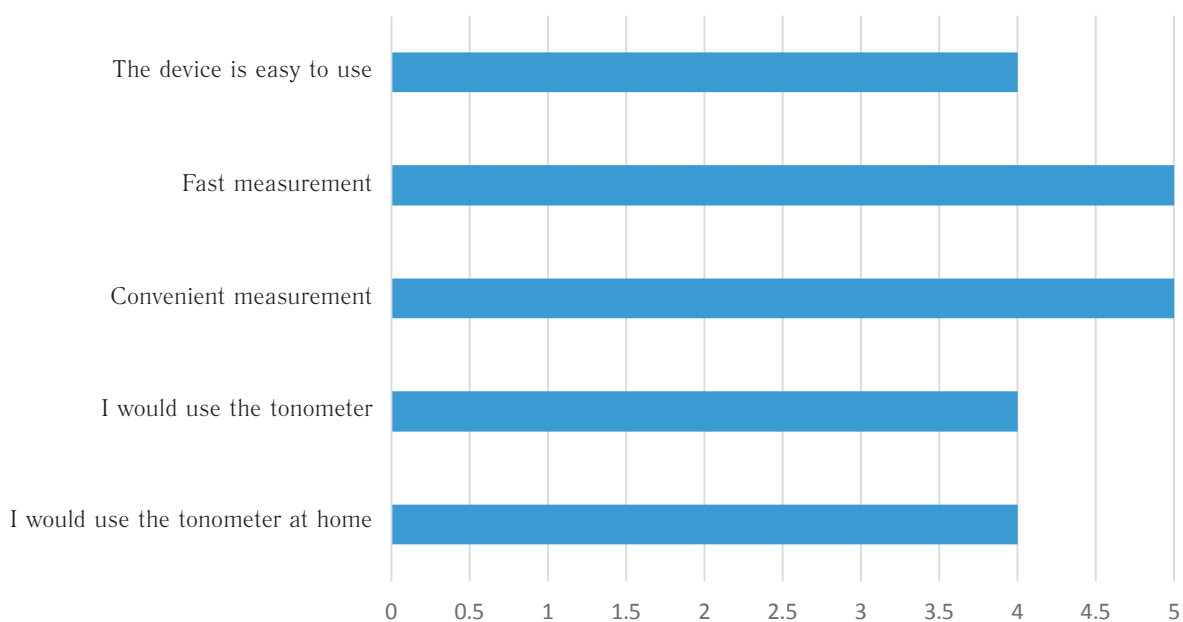
## DISCUSSION

Increased IOP is a major risk factor for the progression of glaucoma. A decrease in the IOP level



**Fig. 1.** Differences between the results of single measurements and near-day monitoring in different groups of patients, mm Hg

**Рис. 1.** Различия между результатами однократных измерений и околосуточного мониторинга у разных групп пациентов



**Fig. 2.** Average responses of patients to a survey regarding ease of use of the device on a 5-point scale

**Рис. 2.** Усреднённые ответы пациентов на опрос относительно удобства пользования прибором по 5-балльной шкале

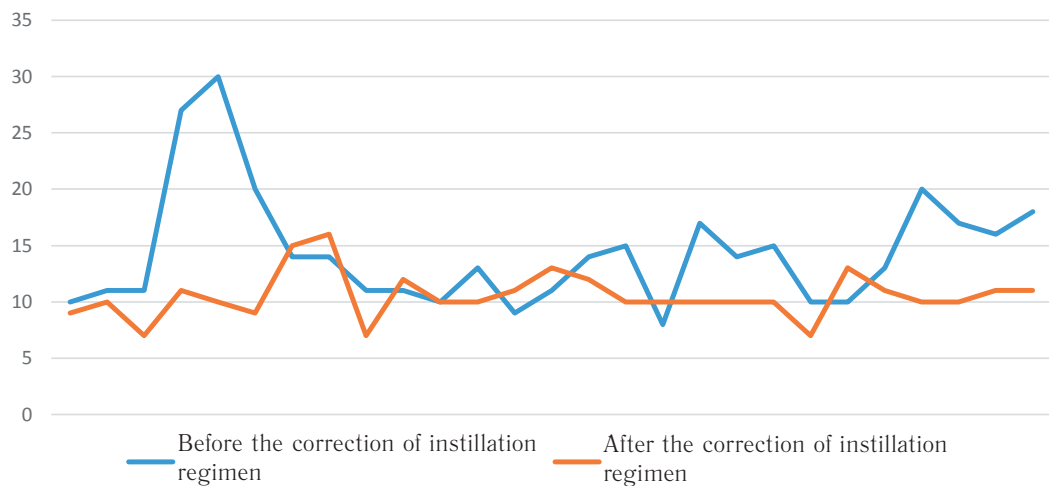
slows down the rate of development of the disease as well as its complications. The assessment of IOP is one of the most important diagnostic methods to determine the effectiveness of treatment. However, a single measurement of IOP during a doctor's working hours does not enable the proper assessment of the true level of intraocular hypertension and daily fluctuations in IOP. Standard examination methods (Goldmann tonometry and Maklakov tonometry) require the participation of medical personnel (a doctor

and/or a nurse), as well as the use of local anesthesia. Independent tonometry enables patients to assess the level of IOP "when staying at home" at different times of the day, without the participation of other people and without the use of special medications. In the present study, the peaks of IOP increased in early morning or late evening hours, beyond the working hours of outpatient ophthalmological institutions. Moreover, the peaks were significantly higher than the average results at a single measurement (Fig. 1).



**Fig. 3.** Achieving the target pressure by adjusting the instillation mode using the example of a patient B. (OD)

**Рис. 3.** Достижение целевого давления с помощью регулировки режима закапывания на примере пациента Б. (OD)



**Fig. 4.** Achieving the target pressure by adjusting the instillation mode using the example of a patient B. (OS)

**Рис. 4.** Достижение целевого давления с помощью регулировки режима закапывания на примере пациента Б. (OS)

Independent participation of the patient in the diagnostic process increases awareness of the importance of following the doctor's instructions that significantly increases the efficiency of treatment. This increased efficiency results in good contact between the doctor and patient that allows to achieve the desired treatment results even without changing the therapy; for example, changing the therapy only by adjusting the instillation regimen. A similar clinical case is presented in Figures 3 and 4.

Patient B. of 60 years had a diagnosis of RE open-angle IIa under therapy glaucoma and LE open-angle IIIa under therapy glaucoma. The patient had concomitant diseases, namely hypertension of the second degree. He did not take drugs to correct his blood pressure level.

The patient visited the Ophthalmology Clinic of the Pavlov State Medical University of Saint Petersburg with complaints of visual impairment. Examination revealed the following: VA RE, 0.8 Sph  $-0.5D$ ; Cyl  $-1.0D$  ax  $100^\circ$  1.0 and VA LE, 0.3 Cyl  $-1.25D$  ax  $85^\circ$  1.0. Corneal thickness was RE/LE = 520/521  $\mu\text{m}$ . Automated perimetry and OCT data of the optic nerve head confirmed the stage of the disease. Drug therapy at the initial visit included a combination drug Ganfort that combined bimatoprost (a prostaglandin analogue) and timolol (a  $\beta$ -blocker) once a day into both eyes. Upon a single IOP measurement with Icare<sup>®</sup> TAO1i, the RE/LE was 10/12 mm Hg at the time of the visit. After a complete examination, the patient received an Icare<sup>®</sup> HOME tonometer for at home use. He used this device to independently measure his IOP according to

the scheme 06:30, 12:10, 17:50, and 22:20 during day 1, at 07:40, 13:20, 19:00 during day 2, at 08:50, 14:30, 20:10 during day 3, at 09:50, 15:30, 21:10 during day 4, and at 11:00, 16:40, and 23:30 during day 5. In parallel with IOP measurements, the patient also measured his blood pressure, pulse, and registered his general condition.

According to the results of circadian monitoring in the first 2 days, the peaks of IOP increases were revealed during the period from 12:00 to 13:00 and 30 mm Hg and 27 mm Hg in the right and left eyes, respectively. After describing the indicators and discussing the data obtained, it turned out that the patient randomly instilled the drops, regardless of the time of day. An explanatory conversation was held regarding the need to comply with the instillation regime. Ganfort instillation was prescribed daily at 12:00 in both eyes. The average IOP level before the correction of therapy was RE IOP  $13.9 \pm 4.0$  mm Hg and LE IOP  $13.4 \pm 4.0$  mm Hg.

At 1.5 months after changing the instillation time, the patient repeated the circadian monitoring. According to the results of a second examination period, the average level of IOP was RE IOP  $10.5 \pm 2.4$  mm Hg (max. 20 mm Hg, at 6 p. m.), and LE IOP  $10.7 \pm 2.7$  mm Hg (max. 19 mm Hg, at 6 p. m.). Maximum values were detected once at 13:10. After discussing the results of the examination, it turned out that on this day the patient instilled drops later than prescribed. It is clearly noticeable that due to the individual approach to patient's drug therapy, it was possible to significantly reduce both the average IOP level and its maximum increases and the range of fluctuations during the day.

The use of the Icare® HOME device for the circadian monitoring of IOP provides opportunities for studying the acrophase of fluctuations in various patients and the selection of drug therapy, including the instillation regimen based on the time intervals of IOP increases. However, further large-scale studies are necessary.

## CONCLUSIONS

1. Comparison of the results of IOP measurements in patients with open-angle glaucoma during a single measurement and during circadian monitoring showed the unreliability of the diagnostic pattern with a single measurement.

2. An increase in the level of compliance was noted with independent monitoring of IOP using the Icare® HOME tonometer.

3. With circadian monitoring, it is possible to correct the regimen of drug therapy in accordance

with individual peaks of IOP, and this in some cases enables to achieve the "target" level of IOP without changing or adding other drugs.

4. Patients of different ages appreciate the convenience and simplicity of using the device.

*The authors declare no conflict of interest.*

The research and publication of the results were not financially supported.

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