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, Konoplianik 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.

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 measurement 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® 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 ± 8.3 years. Group 2 included 17 patients (9 men and 8 women; total 32 eyes) with mean age of 66.2 ± 14.1 years. Group 3 included 11 patients (5 men and 6 women; total 21 eyes) with mean age of 64.5 ± 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® TAO1i tonometer with disposable tips was included.

Subsequently, all patients were trained in the tonometry technique using the Icare® 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® 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 ± 3.7 and 14.4 ± 3.8 mm Hg; group 2: 12.6 ± 4.1 and 13.4 ± 4.9 mm Hg; and group 3: 16.7 ± 7.0 and 16.4 ± 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 ± 7.4 and 17.8 ± 4.2 mm Hg in group 1, 18.9 ± 4.1 and 18.1 ± 4.3 mm Hg in group 2, and 20.9 ± 7.2 and 19.8 ± 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 ± 6.9 and 10.3 ± 2.6 mm Hg; those of group 2 were 11.2 ± 3.9 and 10.0 ± 4.0 mm Hg, and those of group 3 were 11.2 ± 4.0 and 10.4 ± 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® 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
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).
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° 1.0 and VA LE, 0.3 Cyl −1.25D ax 85° 1.0. Corneal thickness was RE/LE = 520/521 μm. 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 β-blocker) once a day into both eyes. Upon a single IOP measurement with Icare® TAO1i, the RE/LE was 10/12 mm Hg at the time of the visit. After a complete examination, the patient received an Icare® HOME tonometer for at home use. He used this device to independently measure his IOP according to

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 B. (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 B. (OS)
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 dur-
ding 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 dis-
cussing the data obtained, it turned out that the pa-
tient 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 ± 4.0 mm Hg
and LE IOP 13.4 ± 4.0 mm Hg.

At 1.5 months after changing the instillation
time, the patient repeated the circadian monitor-
ing. According to the results of a second examina-
tion period, the average level of IOP was RE IOP
10.5 ± 2.4 mm Hg (max. 20 mm Hg, at 6 p. m.),
and LE IOP 10.7 ± 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 cir-
cadian monitoring of IOP provides opportunities for
studying the acrophase of fluctuations in various pa-
tients 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 measure-
ments in patients with open-angle glaucoma during
a single measurement and during circadian monitor-
ing 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 conve-
nience 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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