Original Article

Analysis of 24-hour Monitoring of Intraocular Pressure in 1055 Eyes

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Abstract

Purpose: To investigate the clinical significance of 24-hour monitoring of intraocular pressure (IOP).

Methods: A total of 571 cases (1055 eyes) undergoing 24-hour monitoring of IOP in the Second People's Hospital of Zhengzhou between June 2012 and March 2013 were retrospectively analyzed.

Results: Among all 1055 eyes, 298 had suspected glaucoma (28.2%); 390 (37.0%) were diagnosed with glaucoma but received no treatment (312 with primary open angle glaucoma (POAG) and 78 with primary angle closure glaucoma (PACG)); 215(20.4%) were diagnosed with glaucoma and received medical treatment; 132(12.5%) underwent glaucoma filtration surgery; and there were 20 others. Through 24-hour IOP monitoring, 104 among 298 cases with suspected glaucoma were diagnosed with normal tension glaucoma (NTG), 110 with POAG, and 28 with the secondary glaucoma. Condition assessment and treatment plans were presented for 390 glaucoma cases receiving no treatment. Adjustment was made in the medical treatment of 138 eyes. Following glaucoma filtration surgery, 52 eyes received clinical advice on subsequent treatment.

Conclusion: The simplified 24-hour IOP monitoring method is readily accepted by patients, which is of great significance for providing guidance on the diagnosis of glaucoma and the assessment of the efficacy of glaucoma surgery. However, one-time 24-hour IOP monitoring is not sufficiently efficacious to make a definite diagnosis of NTG. Therefore, long-term follow-up and repeated 24-hour IOP monitoring are required to diagnose NTG, along with a variety of related examinations. (***Eye Science 2013; 28:119-123***)

Keywords: 24-hour IOP monitoring; glaucoma; normal tension glaucoma; IOP

Glaucoma is the primary eye disease causing blindness around the globe. Patients should receive long-term treatment once diagnosed with glaucoma. The prevention and treatment of glaucoma has become a vital public healthcare issue. Glaucomatous optic neuropathy is closely correlated with IOP. Multiple mechanisms underly the apoptosis of retinal ganglion cells, but IOP has been the most easily monitored index[1]. Since IOP is a dynamic biological index, a single IOP measurement is not expected to reveal the peak value, which may postpone diagnosis and treatment. In addition, sharp IOP fluctuation is viewed as an independent risk factor of glaucoma progress[3]. Consequently, a 24-hour IOP monitoring curve is of vital importance for glaucoma patients, especially progressive and severe cases.

Materials and methods

Study subjects

This investigation enrolled 571 patients (1055 eyes: 514 right eyes and 541 left) undergoing 24-hour IOP monitoring from June 2012 to March 2013, including 268 males and 303 females, aged from 7-78 years (average age 41.8±8.4 years).

Measurement instruments

Icare rebound tonometer (Tiolat Oy, Helsinki, Finland).

Measurement methods

At 1 d before measurement, patients were not allowed to drink alcohol or eat foods that potentially affected IOP. To validate the diagnosis, the patients were required to discontinue drug administration for over 10 d and then underwent relevant detection. The patients who were subjected to medical efficacy evaluation were told to intake drugs on schedule. The detection started from 10 a.m. to 8 a.m. next day. IOP was measured every 2 h (except 24 p.m. and 4 a.m.), a total of 10 times daily. The patients were to sleep well. Patients were able to walk freely

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during daytime and IOP was measured as planned. At night, patients could maintain their usual sleep habits, but wake up for IOP measurements. IOP was measured six times for each eye and the mean value was obtained. All IOP measurements were performed by one single physician. IOP measurement was conducted strictly according to the instructions of the I-care rebound tonometer. After IOP measurement, 24-h IOP fluctuation curves were drawn.

Diagnosis criteria for all types of glaucoma[4]

NTG: open chamber angle, 24-h peak IOP < 21 mmHg, fundus and related examinations were in accordance with the diagnosis of glaucoma, excluding alternative diseases. Open-angle glaucoma: open chamber angle, 24-h peak IOP > 21 mmHg, fundus and related examinations were in accordance with the diagnosis of glaucoma. The possibility of other diseases was excluded. Secondary glaucoma: 24-h peak IOP > 21 mmHg, fundus and related examinations complied with the diagnosis of glaucoma. Primary ocular diseases were verified.

Results

Purpose of 24-h IOP measurement

The affected eyes were evaluated and classified before detection to determine the purpose of 24-h IOP monitoring. Among 1055 eyes, 298 (28.2%) were suspected to have glaucoma. The 24-h IOP measurement was conducted to confirm the diagnosis; 390 (37.0%) were diagnosed with glaucoma (without clinical treatment), including 312 with POAG and 78 with PACG. The purpose of 24-h IOP monitoring was to evaluate conditions of diseases and provide references for treatment plans: 215 (20.4%) were diagnosed with glaucoma and were undergoing medication therapy. The 24-h IOP measurement aimed to evaluate the efficacy of medication treatment on IOP control: 132(12.5%) had received glaucoma surgery and the purpose of IOP detection was to evaluate the surgical efficacy. For the other 20 eyes, the purpose of IOP measurement was unclear. The classification of the 1055 eyes before 24-h IOP monitoring is shown in Figure 1.

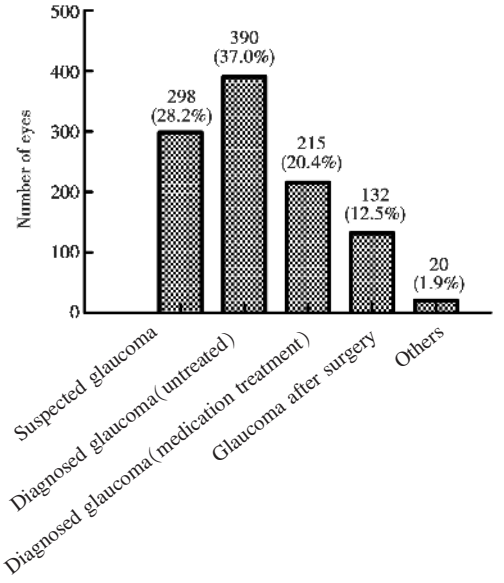

Figure 1 Classification of the diagnosis of 1055 eyes before IOP measurement

Results of 24-h IOP measurement of suspected glaucoma

Among 298 eyes with suspected glaucoma, 104 were found to be normal by 24-h IOP monitoring, 110 had POAG, and 28 had secondary glaucoma. Fifty-six eyes had a IOP variation ≤4 mmHg. Fundus and related examinations did not comply with the diagnosis of glaucoma. Further observations were required. The curve of 24-h IOP monitoring of 104 NTG is shown in Figure 2. The minimal value was 13.10±3.08 mmHg (1 mmHg=0.133 kPa) and the peak value was 18.76±2.34 mmHg; mean IOP changes were 8.21±3.02 mmHg. The minimal value was noted at 8:00 and the peak value at 2:00. Fifty-eight eyes(55.8%) had peak values at 2:00 and 6:00. The distribution of peak and minimal values of NTG cases is illustrated in Figure 3.

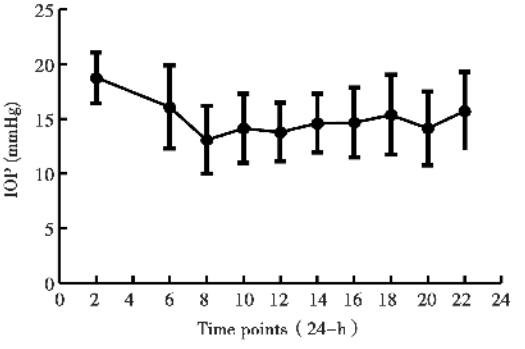

Figure 2 Curve of 24-h IOP monitoring of NTG cases

Results of 24-h IOP monitoring in POAG patients

Among eyes with suspected glaucoma, 110 eyes

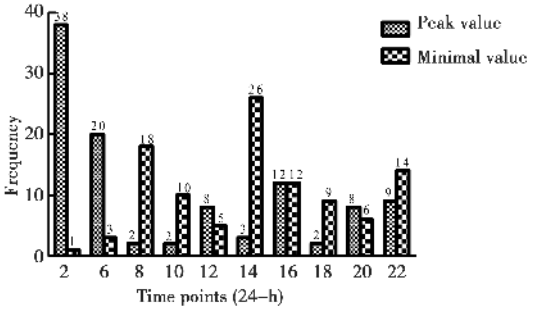

Figure 3 Frequency distribution of peak and minimal values during 24-h IOP monitoring in NTG cases

were diagnosed with POAG. Prior to IOP detection, 312 eyes were diagnosed with POAG. The curve of 24-h IOP monitoring in these 422 eyes with POAG is shown in Figure.4. The minimal value was 22.08±4.41 mmHg (at 16:00) and the peak value was 32.31±5.65 mmHg noted at 2:00. A total of 173 eyes (41.0%) had peak values at 2:00 and 6:00. The frequency distribution of peak and minimal values of POAG cases is illustrated in Figure 5.

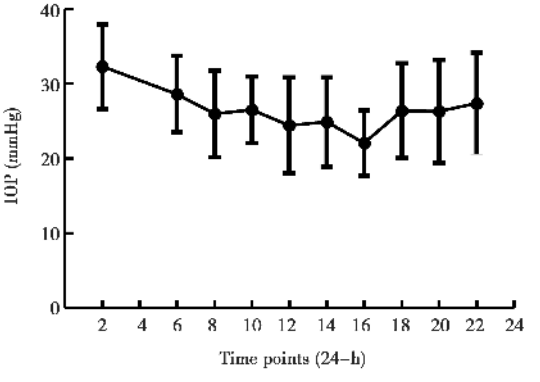

Figure 4 Curve of 24-h IOP monitoring in POAG eyes

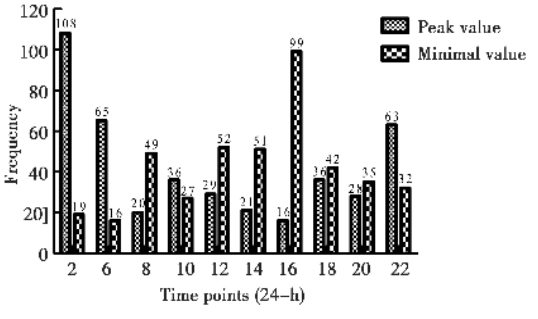

Figure 5 Frequency distribution of peak and minimal values during 24-h IOP monitoring in POAG patients

Results of 24-h IOP monitoring in glaucoma patients

There were 215 eyes diagnosed with glaucoma and receiving medication therapy. Medicine administration was not halted during the 24-h IOP measurement. Ninety-six eyes had an IOP fluctuation ≤ 8 mmHg and a peak value ≤ 21 mmHg. In total, 119 eyes showed an IOP variation > 8 mmHg or/and a peak value > 21 mmHg. The patients' IOP curve, age, and visual field examinations were used for adjustment of medicine administration in 81 eyes and to recommend glaucoma surgery in 28 eyes.

Results of 24-h IOP monitoring after glaucoma surgery

Among 132 eyes, 90 had an IOP fluctuation ≤ 8 mmHg and peak value ≤21 mmHg. Forty-two eyes presented with an IOP fluctuation >8 mmHg or/and peak value >21 mmHg. Anti-glaucoma medication was given for 35 eyes based on the patients' ages and visual field tests.

Discussion

Randomly performed IOP measurements are convenient because glaucoma patients are often admitted during daytime hours. Therefore, IOP measurement during daytime is commonly adopted in clinical practice. Nevertheless, excessively high IOP and sharp IOP fluctuations may occur throughout a 24-h period, and these can accelerate the development of glaucoma[5]. Consequently, 24-h continuous IOP monitoring is of more clinical significance in the diagnosis and evaluation of treatment efficacy for glaucoma patients compared with single IOP measurement. Increased accuracy is obtained by measuring IOP every 2 h, or 12 times per day. However, 24-h IOP monitoring is expensive and patients have to stay in hospital, attended by special clinical staff. An additional limitation is that the patients cannot sleep well due to IOP measurements at night and the disrupted sleep pattern may in turn affect IOP. To resolve this latter issue, the measurement time points of 12:00 and 4:00 are cancelled to reduce the influence upon patients' sleep.

At present, the Goldmann applanation tonometer is the most widely utilized instrument for IOP measurement. The present study utilized the Icare rebound tonometer for IOP measurements in order to minimize the interference on patients' sleep and to more accurately reflect the actual IOP during normal

sleep. Previous findings confirmed that the measurement results are highly consistent between the Icare rebound tonometer and Goldmann applanation tonometer[6]. Patients sit or stand during the IOP measurement, but the IOP measured immediately after sitting can significantly differ from that detected 10 min after sitting[7]. In the present trial, the IOP was immediately measured after awakening the patients, in order to minimize as much as possible the IOP changes occurring during the switch from a supine to a sitting position.

In recent years, 24-h IOP monitoring has become widely applied in the diagnosis and treatment of glaucoma. The number of patients undergoing this test is rapidly expanding. However, the purpose of this test should be specified prior to IOP measurement to provide better accuracy for analysis of the IOP curve. In the present investigation, 20 eyes received 24-h IOP monitoring without any explicit purpose. The test results subsequently provided no guidance for the diagnosis and treatment of these patients. Currently, 24-h IOP measurement is mainly applied in the diagnosis of suspected glaucoma and POAG. In the present study, among 1055 eyes receiving 24-h IOP measurement, 28.2% had suspected glaucoma and 29.6% POAG. The glaucoma patients who were undergoing/had undergone surgery, 24-h IOP monitoring was able to provide a more objective evaluation of the clinical efficacy, guide medicine administration, and evaluate the severity of diseases. The higher recognition of 24-h IOP monitoring meant that a larger proportion of glaucoma patients who were receiving or had undergone medication therapy were likely to receive 24-h IOP measurement.

Outpatient examinations revealed that suspected glaucoma cases receiving 24-h IOP monitoring must meet at least one of the following four criteria: 1. One time IOP detection value > 21 mmHg and the factors related to IOP elevation are excluded; 2. Patients complained of eye swelling; 3. Eccentric defects or central dark spots were noted in the visual field; and 4.Glaucomatous optic neuropathy is observed and alternative diseases causing optic nerve injuries are excluded. In the present case, suspected glaucoma cases underwent 24-h IOP monitoring. Inclusion criteria for glaucoma patients are relatively broad in order to avoid missing the diagnosis of glaucoma. Among 298 eyes with suspected glaucoma, 24-h IOP monitoring revealed that 104 had normal IOP, 110 had POAG, and 28 had secondary glaucoma. The patients diagnosed with glaucoma received timely treatment to prevent the incidence of loss of visual acuity and visual field, indicating that 24-h IOP monitoring can play a significant role in the early diagnosis of glaucoma.

Many patients who were assessed as having normal IOP during the first visit were diagnosed with POAG by 24-h IOP monitoring because their peak IOP occurred at night. In these patients, a one-time IOP measurement during the daytime is likely to miss the peak value. Chi Du[8] conducted 24-h IOP monitoring and found that 39.2% of NTG patients were finally diagnosed with POAG or juvenile glaucoma, which is consistent with previous findings at home and abroad[9,10]. In the present study, 110 among 298 glaucoma suspects were subsequently diagnosed with POAG by 24-h IOP monitoring and their peak IOPs occurred at night.

The 104 eyes with NTG had a mean minimum IOP of 13.10±3.08 mmHg (at 8:00) and a mean peak value of 18.76±2.34 mmHg (at 2:00). A total of 58 eyes(55.8%) had the peak IOP at 2:00 and 6:00. The 422 POAG eyes had a mean minimum IOP of 22.08±4.41 mmHg (at 16:00) and an average peak value of 32.31±5.65 mmHg (at 2:00). In total, 173 eyes (41.0%) had a peak value at 2:00 and 6:00. Therefore, the peak IOP of NTG and POAG eyes occurred mainly around midnight, which was consistent with the findings of Ming Xiao[11].

Among 215 eyes diagnosed with glaucoma and receiving medication therapy, 24-h IOP monitoring displayed that the IOP control was satisfactory in 96 eyes and that the medication treatment should continue. The remaining 119 eyes had an IOP variation > 8 mmHg or/and a peak value > 21 mmHg. The medicine administration was adjusted in 81 eyes and glaucoma surgery was recommended for 28 eyes based upon the patients' IOP curves, ages, and visual field examinations. A previous Chinese study also reported adjustments to medicine administration according the outcomes of 24-h IOP monitoring[12].

Therefore, the combination of 24-h IOP monitoring and IOP-lowering agents can be used to determine the medication and the timing of medicine administration as a promising individualized glaucoma therapy.

Postoperative IOP level plays a key role in surgical success. Some patients seemingly had normal IOP whereas their visual fields were still being injured. A possible explanation may be the fact that the IOP at night is not properly controlled and has a significant variation. During the daytime, the patients tend to have low IOP, which misguides the judgment of physicians. Hence, 24-h IOP monitoring plays a vital role in the evaluation of surgical efficacy. The glaucoma patients treated surgically underwent 24-h IOP monitoring and anti-glaucoma medication was prescribed for 35 eyes, suggesting that a large percentage of patients had uncontrolled IOP post-operation.

The clinical diagnosis and individualized treatment of glaucoma depend on the curve of 24-h IOP monitoring. Increased understanding of 24-h IOP monitoring is likely to result in its wider application in selecting medicines and timing of drug administration, as well as in adjusting drug administration during follow-up. In summary, 24-h IOP monitoring is of vital significance in the diagnosis and treatment of glaucoma.

Disclosure statement

There is no conflict of interest to declare.

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