· Original article ·

Comparison between the intraocular pressure fluctuations measured at home versus in the clinic

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在家中及在医院监测24小时眼压波动值的对比研究

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摘要

目的:本研究旨在比较在家中及在医院监测24h眼压波动的情况。

方法:前瞻性调查研究。本研究共纳入成都地区五个社区共计120名中国籍居民作为研究对象。所有人均接受了临床调查并在家中及医院进行眼压监测,用同一型号眼压计测量了2点、6点、8点、10点、12点、14点、16点、18点、20点、22点的坐位眼压。

结果:在医院监测的24h眼压平均值略低于在家中测量值,平均差为0.27 mmHg,两者比较差异无统计学意义。在医院监测的24h眼压的波动值略高于在家中测量的波动值,平均差为0.01 mmHg。14点在家中测量的眼压平均值(16.04±5.95 mmHg)显著高于在医院测量的眼压平均值(15.43±5.16 mmHg),差异有统计学意义(P<0.05)。在家中及在医院24h眼压监测对于临床上原发性开角型青光眼诊断的一致性为85%(K系数:0.68)。

结论:在医院进行的24h眼压监测的结果与在家中的结果相似。医院24h眼压监测可用于原发性开角型青光眼的诊断。

关键词:眼压;波动;青光眼

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Abstract

• AIM: To compare intraocular pressure (IOP) fluctuations measured at home and in the clinic over a 24-hour period.

• METHODS: A prospective investigational study. A total of 120 Chinese participants were selected from five communities in the Chengdu area. Patients underwent a clinical interview and IOP was measured both at home and in the clinic. IOP were measured at 8 a.m., 10 a.m., 12 a.m., 2 p.m., 4 p.m., 6 p.m., 8 p.m., 10 p.m., 2 a.m., 6 a.m. using the same pneumatonometer. Measurements were taken in the sitting position.

• RESULTS: The average 24-hour IOP measured in the clinic was slightly lower than that at home. The mean difference in 24-hour IOP measurements between home and clinic was 0.27 mmHg. The IOP fluctuation in the clinic was higher than at home (the mean difference was 0.01 mmHg). There was no statistically significant difference in the average 24-hour IOP measured at home *vs* in the clinic. The average IOP measured at 2 p.m. at home (16.04±5.95 mmHg) was significantly higher compared with the measurement in the clinic (15.43±5.16 mmHg) (P<0.05). The overall agreement between 24-hour IOP measurements made in the clinic and at home in diagnosis of primary open angle glaucoma was 85.0% (K coefficient: 0.68).

• CONCLUSION: The 24-hour IOP measured in the clinic was similar to that measured at home, and the method of measuring IOP in the clinic is acceptable in diagnosing primary open angle glaucoma.

• KEYWORDS: intraocular pressure measurement; fluctuation; glaucoma
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INTRODUCTION

Glaucoma is one of the most common diseases worldwide and intraocular pressure (IOP) fluctuation and variation are risk factors for the progression of glaucoma[1-2]. Despite its importance, obtaining the best possible estimate of the true IOP fluctuations is difficult[3-4]. Presently, the diagnosis, treatment and follow-up of glaucoma depend largely on conventional IOP measurements made in the clinic over a 24-hour period[5-6]. IOP fluctuation measurements made at home rather in the clinic are likely to be more convenient and less stressful to the patient provided the measurements made at

home are similar to those made in the clinic. Sometimes, there is a transient rise in blood pressure called the "white-coat effect" when blood pressure is measured in a clinical setting[7]. The rise in blood pressure is due to the environmental change that makes the patient nervous. In the present study, we tested the idea that the same environmental change leads to a change of top fluctuations and we verified that the IOP measured in the clinic can reflect the IOP of patients in their everyday life outside of the clinic. The present study, quantified the variation of IOP over a 24-hour period measured at home and in the clinic to determine whether such measurements are valid for screening individuals at risk for glaucoma.

SUBJECTS AND METHODS

Study Population A total of 120 participants were recruited in the present study from the Chengdu area. Half of them were recently diagnosed with primary open angle glaucoma (POAG), and were previously untreated[8-9]. In addition, 60 residents were given a complete ophthalmic examination and found to have no ophthalmic diseases. Patients who used medication that might affect IOP, a history of eye surgery, ocular inflammation or trauma were excluded from the present study. Moreover, individuals who had an irregular daily sleep schedule were also excluded. None of the subjects presented a narrow angle under slit-lamp examination. This study was approved by the Sichuan University Internal Review Board and written informed consent was obtained from all patients to participate in the present study.

Intraocular Pressure Measurements IOP was measured in the clinic by the same well-trained glaucoma doctor. Subject individuals were asked not to perform any physical activity before the start of the test and to sleep 8h a night. During the nocturnal period, IOP measurements were taken in the supine position 10min after awakening[10]. Each IOP measurement took about 5min per patient. IOPs were measured using a non-contact pneumatonometer (NCT, Cannon HY9-RK-F1 Japan, automatic mode) in the sitting position. IOP measurements were made automatically at least 3 times. The IOP measurements were started at 8 a.m. to minimize the effect of diurnal variation. IOP measured at 8 a.m. in the hospital were measured using both a Goldmann applanation tonometer (GAT) and a NCT to correct IOP using the formula corrected IOP values = IOPNCT + (IOPGAT - IOPNCT at 8 a.m.)[11]. IOP was measured at 8 a.m., 12 a.m., 2 p.m., 4 p.m., 6 p.m., 8 p.m., 10 p.m., 2 a.m. and 6 a.m. Patients were awakened for the 2 a.m. and 6 a.m. measurements. IOP was measured at home by the same well-trained glaucoma doctor as in the clinic. The same devise, preparation and procedures were used to measure IOP in the clinic and at home. The mean of the 12 corrected IOP values over a period of 24-hour is abbreviated as 24-hour IOP. IOP fluctuation is defined as the highest IOP value minus the lowest IOP value measured over a 24-hour period. All of the IOP measurements were made on the right eye except for 8 subjects diagnosed with POAG whose left eyes were measured.

Table 1 Baseline data of all patients, normal and primary POAG

Variable	All participants	Normal	POAG	*P*
No.	120	60	60	
M	52	24	28	0.26
F	68	36	32	0.47
Age	43±14	38±12	45±11	<0.0001

POAG: Primary open angle glaucoma.

Table 2 Mean 24-hour IOP and fluctuation of all patients, normal and primary POAG, in clinic and at home

24-h IOP	Home	Clinic	*P*
Mean IOP			
All participants	17±5	16±5	0.962
Normal	13±2	14±2	0.975
POAG	20±4	19±5	0.919
IOP Fluctuation			
All participants	9±4	9±4	0.998
Normal	6±2	7±3	0.935
POAG	12±3	11±3	0.907

POAG: Primary open angle glaucoma; IOP: Intraocular pressure. Data are presented as mean±SD. Two-sided significance tests were used throughout with $P<0.05$ considered as significant. *P* values were determined by comparing data from the normal group with data from the POAG group.

Statistical Analysis Data are presented as the mean ± standard deviation (SD). Statistical analyses were conducted using SPSS software version 17.0 (SPSS Inc., Chicago, IL, USA). SPSS variables were entered Numeric variables. Dual comparisons were made using the Student's paired *t*-test. Categorical variables were evaluated using the χ^2-test, and the agreement in diagnosing POAG was analyzed with *K* coefficient. The difference between means measured in the clinic and at home were adjusted with the Bland-Altman method[12]. A *P* value of <0.05 was considered statistically significant.

RESULTS

A total of 120 participants (ranging between 18 and 60y old) were recruited in the present study (Table 1). The 24-hour IOP measured for normal IOP patients was statistically lower ($P<0.01$) than that measured for patients with POAG (Table 2). The 24-hour IOP measured in the clinic was statistically non-significantly ($P>0.05$) different compared with the 24-hour IOP measured at home for all groups (Table 2). The average value of the 24-hour IOP fluctuation for normal tension glaucoma patients was statistically lower ($P<0.01$) than that measured for patients with POAG as expected (Table 2). Whereas, the average value of the 24-hour IOP fluctuation measured in the clinic was not statistically different compared with the value measured at home for all groups (Table 2).

The mean IOP measured in the clinic slightly lower than the mean IOP measured at home (Figure 1). The values of IOP measured at each time point between the two groups were

Table 3 Agreement between clinic and home IOP and 24-hour IOP fluctuation, and the sensitivity, specificity and likelihood ratios for a positive and negative test of clinic IOP in predicting high home IOP

Measurement	Agreement(%)	Sensitivity(%)	Specificity(%)	Positive likelihood ratio	Negative likelihood ratio	*K* coefficient(95% CL)
Mean	89.17	86.79	91.04	9.69	0.15	0.78(0.63-0.87)
Fluctuation	80.00	78.87	81.63	4.29	0.26	0.59(0.42-0.70)
Both	85.00	77.87	89.33	7.29	0.25	0.68(0.51-0.81)

IOP: Intraocular pressure; CL: Confidence limit. The positive likelihood ratio indicates how much the odds increase for a patient that was diagnosed at home as ocular hypertensive compared to when a patient was diagnosed as ocular hypertensive in the clinic. The negative likelihood ratio indicates how much the decrease for a patient that was diagnosed at home as ocular hypertensive compared to when a patient was diagnosed in the clinic as ocular normotensive.

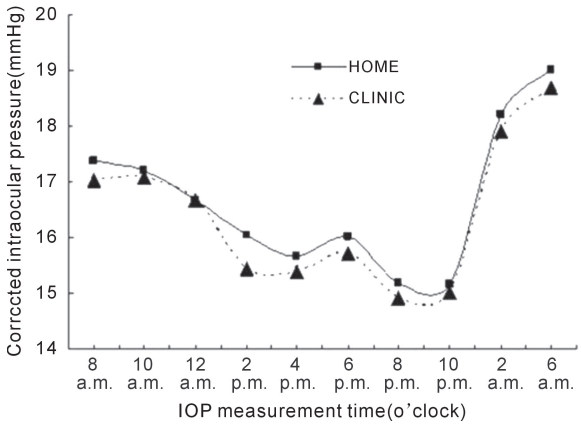

Figure 1 The 24-hour IOP measured in the clinic (solid triangles with a dotted line) and at home (solid squares with a solid line) The standard error is about the same or less than the size of the symbol.

not significantly different except for the values measured at 2 p.m. which were significantly lower ($P < 0.05$) when measured at home (15.43±5.16 mmHg) compared to the clinic (16.04±5.95 mmHg). The mean 24-hour IOP measured at home were not significantly different with those measured at the clinic (Table 1, Figure 1).

The Bland-Altman's approach was used to compare the agreement between the measurements made at home and in the clinic (Figure 1). The agreement between the two methods was moderate (overall agreement: 85.00%, *K* coefficient: 0.68, 95% confidence limit: 0.51-0.81). Clinical IOP values had a sensitivity of 77.87% and a specificity of 89.33% in predicting a high IOP at home (Table 3).

DISCUSSION

Intraocular pressure and fluctuation are associated with the progression of private open-angle glaucoma[13], and 24-hour IOP monitoring is particularly important. Most studies monitored intraocular pressure for 24h in a particular laboratory or surveillance room in the hospital[14-16]. However, intraocular pressure may change with the environmental and daily rhythm of life. We designed the current study to test whether the intraocular pressure and its fluctuation measured in the laboratory or in the surveillance room is consistent with that measured in daily life.

The present study showed that the 24-hour IOP measured using a pneumatonometer[17] in the clinic was similar to that measured at home and the measurements were found accurate and highly reproducible. Although, the 24-hour IOP is slightly higher when measured at home compared to when measured in the clinic, the values are not large enough to warrant separate testing at home or at the clinic. The findings of the present study are important because the magnitude of 24-hour IOP fluctuation is a separate and independent risk factor for glaucomatous damage[18].

A study reported that the vision in eyes with 24-hour IOP greater than 17.5 mmHg were likely to worsen by 1 unit of visual field defect score at subsequent follow-up visits compared with eyes with an average intraocular pressure less than 14 mmHg[19-20]. 24-hour IOP fluctuation larger than 8 mmHg is a significant risk factor for POAG[21]. In the present study, both the mean IOP and the 24-hour IOP fluctuation were significantly higher in POAG patients compared with the control group.

The overall agreement between 24-hour IOP measured in the clinic and at home was 85.00% in the present study. This agreement could be improved with a correction for the central corneal thickness. In the present study, 24-hour IOP were measured without a correction factor for central corneal thickness because there is considerable disagreement as to how corrections should be calculated using applanation methods[22-23]. Better agreement between 24-hour IOP measured in the clinic and at home could be achieved by considering this phenomenon. Although there are many new instruments designed to measure intraocular pressure[24-25], it is impractical to use them on a large scale for clinical application in developing countries, because they are expensive and not easy to control. The 24-hour IOP measured at home might be convenient, less stressful and cost effective for the patients compared with measurements made in the clinic. Measurements made in the clinic would be expected to be more repeatable compared to those measured at home because of a more controlled environment and use of the same devise by a skilled technician. The method for measuring 24-hour IOP which we used in this study may be more suitable for the diagnosis of open angle glaucoma. 24-hour IOP fluctuation was especially repeatable and reliable and may be the best indicator for the diagnosis of glaucoma.

There are some limitations in the present study. For instance, measurements were made only for one day so we need to increase the measurement frequency to reduce the bias error. The present study was a single center study with small

sample, and in future studies we propose to increase the sample size with a multi-center investigation.

In summary, both the mean IOP and the 24-hour IOP fluctuation measured in the clinic were similar to that measured at home with high stability and good reproducibility. The method of measuring IOP in the clinic could reflect the real IOP in daily life which is applicable to the diagnosis of POAG.

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