ORIGINAL ARTICLE

Effects of Fluid Ingestion on Intraocular Pressure in Normal Young Malaysian Adults

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ABSTRACT

Introduction: Intraocular pressure (IOP) is an important parameter in diagnosing and monitoring glaucoma. IOP is dynamic and its measurement and monitoring is challenging. Water Drinking Test (WDT) is a test to evaluate the fluctuation of IOP due to fluid ingestion. This study aimed to investigate the effect of WDT on IOP in normal young healthy adults. **Materials and Methods:** Eighty participants were recruited in this prospective study. Comprehensive optometric examination were done including Goldmann application tonometry and visual field (VF) testing. Refractive error were objectively measured using Shin Nippon SLM-500 auto-refractometer. VF testing was done using automated perimetry. All procedures were performed between 08:00 to 12:00 PM, and every 5 minutes for 30 minutes after 1000mls of water. All data were analysed using repeated measures analysis of variance (RM-ANOVA). **Results:** Immediately after the WDT, the IOP increase to its peak at 10 minute and reducing trend was observed from the peak to the 30 minutes timeline. RM-ANOVA analysis revealed significant changes in IOP measurements between baseline and 30 minutes observation period ($P < 0.001$). Post hoc comparisons using the Tukey HSD test indicated the changes in IOP between right after drinking to at 10 minutes (mean = 17.8, SD = 2.3) was significant compared to other time intervals ($P < 0.001$). No significance difference ($P = 0.09$) in IOP between baseline and 30 minutes. **Conclusion:** WDT is a meaningful, quicker alternative test in attempting to uncover diurnal IOP characteristics in clinic, thus reducing both time requirements and associated costs.
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Keywords: Water drinking test (WDT), Diurnal variation, Intraocular pressure, Fluid ingestion, Healthy young adult

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INTRODUCTION

Glaucoma is a group of diseases characterized by optic neuropathy progression due to loss of the optic nerve fibre layer which resulting in visual field reduction. Intraocular pressure (IOP) is an important parameter in early detection and monitoring glaucoma. Despite knowing that lowering IOP is crucial in monitoring glaucoma progression, the approach in monitoring remains inadequate (1-4). Commonly, studies related to IOP monitoring are done during working hours, however, recent report suggested an approximation of 75% of cases has been reported that maximum IOP occurs mostly outside these times (5,6). It is a fact that IOP fluctuations may occur due to several factors including ingestion certain amount of water (7,8), different postural position (2,9), physical activities (10,11), time (12) and even changes in accommodation (13,14). This indirectly indicates inaccuracy of IOP measurement could be multifactorial.

Several approaches has been suggested to determine the maximum IOP. Mottet et al. (15) had utilised continuous contact lens sensor for 24-hour diurnal monitoring. However, this approach was both time and resource-consuming. Not to mention this approach could also lead to inaccuracy of IOP measurement as it is exposed

to other external factors such as corneal curvature, thickness and hysteresis. Alternatively, water drinking test (WDT) has been proposed to detect IOP peaks and evaluate variations of IOP. The IOP measurement can be done in various time intervals; from 15-minute to 2-hours interval throughout the day. Recent works (16,17) has reported that the WDT are correlated with maximum diurnal IOP. With its potential of time and resource savings, the WDT could be the alternative to estimate maximum IOP for 24-hour monitoring. To the best of our literature search, there is no report on IOP changes using WDT test from Malaysian population. Thus, this study aimed to investigate the effect of WDT on IOP and maximum response time on IOP changes in young adults.

MATERIALS AND METHODS

Eighty young adults were recruited in this prospective study via convenience sampling. The study protocols were approved by the International Islamic University Malaysia (HUM) Research Ethics Committee (IREC2019-125) and conform with the tenets of the Declaration of Helsinki. Written consent was obtained from each participant prior to data acquisition. Inclusion criteria includes aged 20 - 50 years old with no history or pending diagnosis of primary open angle glaucoma (POAG) or normal tension glaucoma (NTG) in either eye. Retinal evaluation with emphasis on glaucomatous optic disc and visual field loss were evaluated by a senior consultant glaucoma specialist. Patients with a history of ocular trauma, evidence of active ocular infection in either eye, or significant underlying ocular pathology affecting the anterior eye including ocular surface lesion/trauma, cornea lesion, anterior chamber and lens abnormalities were excluded (18-20). For posterior segment, ophthalmic retinal and neurological were also excluded (21-24). In addition, participants with history of renal disease or organ failure due to risk of excessive fluid intake or those with swallowing difficulties were also excluded (1).

Comprehensive optometric examination including visual acuity, slit-lamp biomicroscopy, Goldmann applanation tonometry (GAT) and pupil examination were done prior to recruitment (25,26). All assessment were done on both eyes, however, only data recorded from one eye were used for analysis. Refractive error was measured using Shin Nippon SLM-500 autorefractometer (Shin Nippon, Tokyo, Japan), with five (5) readings were automatically acquired, and the average were recorded. Central corneal thickness (CCT) was measured using Oculus PARK1 (OCULUS Inc, Arlington, WA, USA) with five (5) readings were automatically acquired, and the average were recorded. IOP was measured by Goldmann applanation tonometer (GAT) (GAT, Haag-Streit, Koeniz, Switzerland) with average of three (3) reading were recorded. Visual field (VF) testing was performed on each eye separately using Humphrey Visual Field Analyser 3 (Carl Zeiss Meditec, Jena, Germany) using a 24–2 testing modality. To limit the influence of diurnal variations in IOP, all measurements were carried out between 08:00 to 12:00 PM, with all examination were done by a group of qualified optometrists. All participants were reminded not to ingest any food or liquid three (3) hours before the baseline measurements of IOP. After baseline measurements, participants drank 1000 mL of water in 10 minutes. IOP measurements were repeated at 5, 10, 15, 20, 25 and 30 minutes into the WDT.

All data were analysed using the IBM SPSS (Predictive analytics software) (Version 25, SPSS Inc., Chicago, IL, USA). Shapiro-Wilk test was used to check normality of data. All data were recorded in mean and standard deviation (mean ± SD). Repeated measures analysis of variance (RM-ANOVA) with Tukey Honest Significant Difference (HSD) post-hoc test for multiple comparisons was carried out to investigate the changes in each of measured parameter after water ingestion with each time interval. P-value was set at 0.05 as level of significance.

RESULTS

Data from eighty eyes of 80 healthy young adults were analysed in this study. Shapiro-Wilk test revealed all parameters were normally distributed. The baseline IOP were 12.7 ± 1.4 mmHg. While refractive error and CCT were -3.23 ± 0.45 DS and 523 ± 34 µm. This study found that immediately after drinking 1000 ml of fluid, the IOP increase to its peak at 10 minute and reducing trend was observed from the peak to the 30 minutes timeline. The mean and standard deviation for IOP measured in every time interval are summarised in Table 1. RM-ANOVA analysis revealed statistically significant changes in IOP measurements between baseline and 30 minutes observation period. Post hoc comparisons using the Tukey HSD test indicated that the mean IOP between right after drinking to at 10 minutes (mean = 17.8, SD = 2.3) was significantly different than the other time intervals ($P < 0.001$) (Fig. 1). However, no significant difference were found in IOP measurement made between baseline and at 30 minutes interval ($P = 0.09$). The dynamic changes in IOP during 30-minutes observation period are shown in Fig. 1.

Table I: The mean and SD of IOP for 30 minutes observation period (n=80)

Time interval	IOP (mmHg) (mean ± SD)	P-value[a]	
Baseline	12.7 ± 1.4	-	
5 minutes	14.3 ±1.8	< 0.001[a]	
10 minutes	17.8 ± 2.3[b]	< 0.001[a]	
15 minutes	17.3 ± 1.6	< 0.001[a]	
20 minutes	16.0 ± 1.5	< 0.001[a]	< 0.001[a]
25 minutes	15.0 ± 1.9	< 0.001[a]	Post hoc analysis[b], < 0.001
30 minutes	14.2 ± 1.2	0.09	

[a]P-value analysed using RM-ANOVA (Baseline vs. 5 minutes, Baseline vs. 10 minutes, Baseline vs. 15 minutes, Baseline vs. 20 minutes, Baseline vs. 25 minutes and Baseline vs. 30 minutes

[b]Tukey HSD test

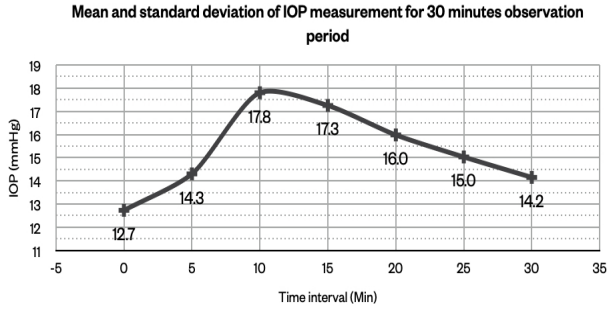

Fig 1 : The dynamic changes in IOP measurement for 30 minutes observation period (n=80)

DISCUSSION

The WDT indicates the efficiency of the fluid outflow system of the eye. The exact mechanism of IOP increase is not clear and still debatable (1,27). There are several hypotheses been proposed to elucidate this process. Few studies (28,29) had commented that the WDT could lead to increase in IOP by inducing changes in episcleral venous pressure by causing reduction in aqueous outflow which in turn lead to increase in IOP. Recent works (27,30,31) also suggested that increase in aqueous production somehow interrupt the balance of circadian rhythm of IOP following to water drinking could also lead to increase in IOP. Many researchers had hypothesised that choroidal expansion or changes in choroidal thickness during WDT causing the increase in IOP, however the findings were still debatable with several reports in agreement with theory (32-34), while group of studies disagree (35-38).

This study findings showed subsequent to the WDT, there was an immediate increase in IOP and recedes steadily within 30 minutes. Our findings in agreement with previous studies that reports variation in fluid volume intake and duration of drinking time taken would give different values of IOP changes (39,40). It is challenging to compare our results with other studies as there are no standardisation in conducting the test. Recent work (41) reported an increment of 6.6 ± 2.9 mmHg after ingestion of 800 mL of water within 5 minutes. Previous work (42,43) reported an increment of 5.00 ± 1.00 mmHg 2.24 ± 0.31 mmHg respectively after 1 liter of fluid ingestions. While another study (39) reported increment of 4.70 ± 0.90 mmHg after taking fluid at 14 mL/kg body weight within 5 minutes. Thus, the amount of fluid ingested are varies between studies. In addition, different duration of drinking time and the time interval for IOP measurement also varies between one study to another. Several studies measured the IOP within the first 5 minutes (39,43) after the WDT, while other group of studies at 10 minutes (44), 15 minutes (1,16,35,45), and even in ranges between 5 - 15 minutes (47)

Increment of IOP were also noted slightly different with other studies. This study found that the maximum IOP was at 10 minutes after the WDT. This is in agreement with a previous work (43,44). However, several studies reported the maximum IOP was observed at 5 minutes (39), or even at 15 minutes (41). This result suggest that the time required could be related different ethnicity with studies from countries near the equator (43) showed faster increment compared to farther countries like Japan (41). Study from Indian and East Indian population (43). Nonetheless, we postulated that this study findings could be due to our sample, in which most of them are young and healthy adults. It is assumed that the ocular drainage system are well-function and still intact. Recent study had commented that increased age is one of factors that leads to notable increase in IOP compared to younger individuals (48). And the time difference in reaching the maximum IOP changes could be due to variations of hydration levels within the ocular dimension (46).

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CONCLUSION

Water Drinking Test (WDT) is a meaningful, quicker alternative test in attempting to uncover diurnal IOP characteristics in clinic, thus reducing both time requirements and associated costs.

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