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ORIGINAL ARTICLE

Correlation between Intra Ocular Pressure after Water Drinking Test and OCT Changes in Preperimetric Primary Open Angle Glaucoma

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Abstract

Background: ***Glaucoma is clinically defined as progressive optic neuropathy due to an intra-ocular pressure that is sufficiently high to be intolerable for ocular neural tissue. This pressure interferes with proper oxygenation, leading to the loss of the cells that line the retina.***

Objective: ***Assessing the relation between the peaks of intraocular pressure measurement taken while drinking water test and the changes in spectral domain optical coherence tomography (SD-OCT) in pre-perimetric glaucomatous (PPG) eyes.***

Patients and methods: ***A prospective study included cases attending the outpatient clinic at Cairo Fatemic Hospital from October 2019 till March 2021. The study included 50 subjects aged over 35, with minimum best corrected visual acuity of 0.8, with an open angle of the anterior chamber, explicit ocular media, and matched glaucoma suspect criteria. The study correlated the mean IOP changes after the Water Drinking Test (WDT) and OCT parameters for the optic nerve head (ONH) & retinal nerve fibre layer (RNFL).***

Results: ***The alterations in intraocular pressure following the Water Drinking Test were positively correlated with the vertical cup/disc ratio (VCDR). When looking at intraocular pressure changes following WDT about retinal nerve fibre layer thickness, rim area, & disc area, a strong negative connection was seen.***

Conclusion: ***WDT in PPG patients showed significant correlations with structural OCT parameters and can be considered for detecting patients at risk for disease progression.***

Keywords: Intra Ocular Pressure; Water Drinking Test; Optical Coherence Tomography; Pre-perimetric Primary Open Angle Glaucoma

1. Introduction

Glaucoma is clinically known as progressive optic neuropathy due to an intra-ocular pressure, which is sufficiently high to be intolerable for ocular neural tissue, so that it interferes with proper oxygenation, causing the retinal ganglion cells to die off. Cupping of the optic nerve head, localized or widespread retinal nerve fibre layer thinning, and visual field (VF) loss are the hallmarks of this optic neuropathy.[1,2]

The presence of typical glaucomatous optic neuropathy (GON), as well as destruction to the RNFL before the development of VF abnormalities, is referred to as pre-perimetric glaucoma. [3]

High intraocular pressure (IOP), advanced age, being Black, as well as having a family history of glaucoma are among the risk factors for glaucomatous damage.[4]

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An intended point of pressure is one beyond which more harm is unlikely to materialize. Nevertheless, even when intraocular pressure measurements are deemed to be within acceptable ranges, a considerable portion of individuals experience glaucomatous development. The intraocular pressure changes throughout the day or pressure peaks that aren't always noticeable during exams could be to blame.[5,6,7]

The water drinking test displays a strong relationship between IOP peaks measured during a daily tension curve and IOP peaks observed following water overload.[8]

The study aimed to assess the relation between the peaks of intra-ocular pressure detected during the WDT and the changes in spectral domain OCT in pre-perimetric glaucomatous eyes.

2. Patients and methods

The participants in this study were those who were seen in the outpatient clinic at Cairo Fatemic Hospital between October 2019 and March 2021. The research was carried out in a manner that was compliant with the principles established by both the Al Azhar Medical Research Ethical Committee and the Local Research Committee. All of the subjects gave their consent after being fully informed.

Patients and inclusion criteria

Fifty subjects aged over 35 with the best corrected visual acuity of 0.8 or better & explicit ocular media were involved. All persons matched the Glaucoma suspect criteria stated by the European Glaucoma Society: peak IOP 21 mmHg, open angle of the anterior chamber, standard visual field, and suspected ONH and RNFL. An optic nerve head that was suspected was characterized as a rim area with a thickness of under two clock hours, as well as an excavation of the optic nerve head that was not undermined but appeared to have been punched out. A defect that did not approach the size of a significant vein or that did not reach the margin of the disc was considered a suspected RNFL defect.

Exclusion criteria

Patients with a history of intraocular surgery.

Patients with lens opacity above 1 are consistent with the lens opacity classification system (LOCSIII).

Patients with a history of diabetes & neurological disorders that might affect the visual field.

Patients on steroid treatment.

Procedures

Standard clinical ophthalmologic examination:

History (present and past ophthalmologic and medical history, family history for glaucoma): visual acuity testing with slit lamp examination, Snellen's chart of the anterior segment & Fundus biomicroscopy, gonioscopy with the Goldmann 3-mirror contact lens, Goldmann applanation tonometry.

Functional test:

Visual field examination (Humphrey automated field analyzer, Carl Zeiss Meditec AG, Germany) SITA standard, central 30-2 threshold program.

Structural, morphological tests:

Optical coherence tomography (Topcon® DRI-OCT Triton, Tokyo, Japan) was used for structural evaluation of ONH and RNFL thickness. Central corneal thickness (CCT) measurement (Oculus, Pentacam®, Optikgeräte GmbH, Germany) was done for IOP measurements correction.

Water drinking test (WDT):

IOP measurements were made by the same tonometer and the same examiner by a calibration-checked Goldmann applanation tonometer with the person seated at the slit lamp. One drop of 0.4% Benoxinate hydrochloride & one drop of fluorescein sodium functioned for topical anaesthesia and staining, respectively. The initial (Zero time) IOP was measured when the patient was fasting fluids for at least two hours. The WDT was performed by asking the patient to drink one Liter of water within 5 min; IOP was then determined three times at 15, 30, and 60 min. IOP measurements were corrected according to CCT using the Ehlers formula.

We correlated IOP fluctuations after WDT and OCT parameters for ONH and RNFL.

Statistical analysis

The Statistical Program for Social Science (IBM SPPS) version 20.0 was utilized to analyze the data. To express the quantitative information, a mean plus or minus the standard deviation (SD) was employed. To express the qualitative data, the rate and the percentage of occurrence were used. When comparing the two means, a paired t-test of significance was utilized, and a P-value under 0.05 was regarded as showing statistical significance.

3. Results

The trial done on 50 subjects, 38 ladies (76 percent) & 12 males (24percent). Age range was 35-73 years (Mean ±SD 47.08±9.86). Patients underwent WDT, IOP measurements at zero-time, 15 min, 30 min and at 60 min are summarized in Table 1. Mean IOP changes at 30 minutes after WDT were highly significant and were used for further correlations.

Table 1. Comparison between baseline IOP and later IOP measurements after WDT at 15, 30, and at 60min.

IOP	RANGE (MMHG)	MEAN ±SD	MEAN DIFF.	T-TEST	P-VALUE
BASELINE	10–18	13.48±2.29			
AT 15 MIN.	10–19	14.50±2.33	1.02	-3.071	0.006*
AT 30 MIN	11–21	15.78±2.46	2.30	-12.102	<0.001**
AT 60 MIN	10–18	13.66±2.36	0.18	-1.691	0.105

p-value >0.05 Non-significant; *p-value <0.05 Significant; **p-value <0.001 Highly significant

Structural OCT parameters included RNFL thickness and ONH measurements. Data were summarized in Table 2, 3.

Table 2. Retinal nerve fiber layer thickness of the studied subjects (n=50).

RETINAL NERVE FIBER LAYER THICKNESS	RANGE (μM)	MEAN ±SD
AVERAGE	64–133	103.14±13.37
SUPERIOR	51–170	126.42±22.41
INFERIOR	100–165	131.92±17.10
TEMPORAL	45–119	76.08±14.72
NASAL	40–124	78.70±16.73

Table 3. Optic nerve head measurements the studied subjects (n=50).

DISC PARAMETERS	RANGE	MEAN ±SD
RIM AREA (MM^2)	0.68–2.2	1.28±0.33
DISC AREA (MM^2)	1.43–3.62	2.20±0.49
LINEAR CDR	0.51–0.84	0.64±0.08
VERTICAL CDR	0.48–0.79	0.61±0.07
CUP VOLUME (MM^3)	0.05–0.59	0.22±0.11

CDR: Cup-disc ratio

Mean IOP changes at 30 minutes after WDT were correlated to RNFL thickness and ONH measurements Table 4,5.

Table 4. Correlation between Mean IOP changes at 30 minutes after WDT with RNFL layer parameters (μm), using Pearson Correlation Coefficient.

RETINAL NERVE FIBER LAYER THICKNESS	CHANGES OF IOP	
	R	p-value
AVERAGE	-0.743	<0.001**
SUPERIOR	-0.659	<0.001**
INFERIOR	-0.646	<0.001**
TEMPORAL	-0.377	0.007*
NASAL	-0.398	0.004*

R: Pearson Correlation Coefficient,

Table 5. Correlation between mean IOP changes at 30 minutes after WDT and ONH parameters, using Pearson Correlation Coefficient.

DISC PARAMETERS	CHANGES OF IOP	
	R	p-value
RIM AREA (MM^2)	-0.351	0.012*
DISC AREA (MM^2)	-0.316	0.025*
LINEAR CDR	0.084	0.561
VERTICAL CDR	0.315	0.026*
CUP VOLUME (MM^3)	-0.128	0.376

Study results showed a statistically significant negative association amongst changes of IOP after WDT and RNFL thickness in all quadrants Table 4 , rim area and disc area, while there was a statistically significant positive correlation between changes of IOP after WDT & VCDR in the studied patients Table 5.

4. Discussion

Structure alterations in the onychopharyngeal or retinal nerve fibre layer without corresponding functional modifications to conventional automated perimetry describe pre-perimetric glaucoma, an early stage of open-angle glaucoma.[9] An intended point of pressure is one beyond which more harm is unlikely to materialize. [10] Despite IOP levels being deemed within appropriate limits, a substantial portion of individuals have glaucomatous development. [11] Possible causes include pressure peaks that aren't always detectable during office examinations or variations in intraocular pressure throughout the day. [12]

When comparing intraocular pressure peaks measured during a daily tension curve with those observed following water overload, the WDT shows a strong connection. [13]

The present study assessed the relationship between IOP fluctuation after WDT and OCT parameters. This study shows that the highest mean of IOP was after drinking water for 30 min, and the range of IOP fluctuation during WDT was 1-5 mmHg, which agrees with the result of other studies like Kerr and Danch-Meyer.[14] While CHEN et al. found that the highest mean of IOP was at 15 min and the range of IOP fluctuation during WDT was 7.7 mmHg, it could be explained by the fact that the long fasting hours (8 hours) before a test and high volume of water (1.5 litres).[15]

The range of IOP fluctuation is an essential predictor for progressing PPG to OAG. As to the research conducted by Nouri-Mahdavi et al., eyes with intraocular pressure fluctuations beneath three mmHg showed little change over time, in contrast to eyes that showed noticeable improvement.[16] We correlated IOP fluctuations after WDT, which is considered an excellent, provocative test for open-angle glaucoma (OAG),[17] and ONH and RNFL OCT parameters, and it is considered a reliable diagnostic tool for OAG.

There was a strong positive association between the change in intraocular pressure after WDT and vascular cerebral damage rate and a strong negative association between the change in IOP after WDT and retinal nerve fibre layer thickness. A significant negative correlation with rim area, disc area, and RNFL parameters might be explained by the possible effect of fluctuation of IOP in two ways: mechanical (pressure-related) and vascular (non-pressure related) insult to ganglion cells and their axons. [18,19,20]

5. *Conclusion*

The results of this study highlight WDT's other usefulness besides its use as a provocative test to detect IOP spikes. It also gives a clue to disease progression and anatomical structural deterioration in PPG patients through significant correlations between increased IOP after WDT, increased VCDR, and decreased RNFL thickness, rim area, and disc area.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

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Conflicts of interest

There are no conflicts of interest.

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