COMPARISON OF WATER DRINKING TEST
RESPONSE BETWEEN MEDICALLY
CONTROLLED AND SURGICALLY
CONTROLLED GLAUCOMA
PATIENTS

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Abstract

**Purpose:** To evaluate whether patients who have undergone trabeculectomy with mitomycin C have a different intraocular pressure (IOP) response profile after the water drinking test (WDT) from that of patients who are medically managed with a similar baseline IOP and level of visual field (VF) damage.

**Design:** Prospective observational study.

**Participants:** 12 glaucoma patients with IOP controlled by trabeculectomy and 12 with medically treated glaucoma matched for level of VF damage and IOP at baseline (7-14mmHg).

**Methods:** All patients underwent the WDT, which involved drinking 1000ml of water in 15 minutes.

**Main outcome measures:** The IOP was measured before the WDT and subsequently at 15-minute intervals for 1 hour. The peak IOP with the WDT was compared between both groups using paired t tests.

**Results:** Baseline IOPs were 10.3 ± 2.2mmHg in surgically treated and 11.1 ± 1.7mmHg in medically treated eyes. After the WDT, mean IOPs in the surgically and medically treated groups were 10.6 ± 2.1mmHg and 15.1 ± 2.4mmHg. Mean maximum IOPs were 11.6 ± 2.4mmHg and 17.2 ± 2.3mmHg in the surgically and medically treated groups, respectively (p < 0.0001), increases of 17.6% and 54.9%. Ranges of IOP during the WDT were 2.2 ± 1.2mmHg and 5.7 ± 1.8mmHg in the surgically and medically treated patients (p < 0.0001).
Conclusion: Patients with advanced glaucoma who are medically controlled show greater IOP elevation and peak IOP after the WDT than eyes that have undergone trabeculectomy.

Introduction

Glaucoma treatment is based mainly on intraocular pressure (IOP) reduction, to prevent optic disc damage. However, it has been reported that a significant group of patients still experience progression of glaucoma despite IOP measurements in the ophthalmologist’s office within normal limits. However, it has been suggested that this finding may be explained by the occurrence of pressure peaks not detected by single measurements in the clinic. Drance demonstrated that almost one third of patients with single IOP measurements during office hours may present pressure peaks only detected during a 24-hour pressure curve. Also, IOP fluctuation has been identified as a risk factor for the progression of glaucoma (Chaunhan et al., 1991).

Several studies have evaluated the 24-hour diurnal curve with topical antiglaucoma treatments and more recently, with well-functioning trabeculectomy (Liu et al., 2003).

Despite its importance, monitoring the IOP through the 24 hours of the day is not always feasible in the clinical practice. As an alternative, a modified diurnal tension curve consisting of four to five measurements during working hours is routinely used. However, this test may miss up to 70% of IOP peaks, because most of the highest IOP levels occur at 6 AM with the individual in the supine position. A provocative water-drinking test (WDT) may be a practical way to estimate diurnal IOP peaks (Mosaed et al., 2005).

Previous reports have demonstrated that IOP elevation during a WDT is a risk factor for the development of glaucomatous visual field progression (Yoshikawa et al., 1993).

Materials and Methods

This study includes 24 eyes:

- 12 eyes with medically controlled open angle glaucoma.
- 12 eyes with surgically controlled open angle glaucoma.
Inclusion criteria:
- Visual acuity (VA) in study eye of 20/40 or better.
- Mean deviation of worse than 5 decibels (dB) on 2 consecutive reliable Swedish Interactive Thresholding Algorithm standard 24-2 VF tests in the study eye.
- IOP between 7 and 14mmHg on 3 consecutive visits before recruitment.
- The surgical treatment group had undergone trabeculectomy with mitomycin C (0.4mg/ml for 2-4 minutes).

Exclusion criteria:
- A history of secondary glaucoma
- Pseudoexfoliation
- Pigment dispersion or had undergone argon or selective laser trabeculoplasty at any stage.
- Surgical patients were excluded if they were on any concurrent topical antihypotensive medical therapy.
- Patients on oral acetazolamide.
- Unreliable VF's or unreliable applanation tonometry.

All patients underwent a complete ophthalmological examination, which included Snellen VA. IOP measured with Goldmann applanation tonometer, and a dilated stereoscopic fundus examination. Patients also had automated full-threshold perimetry performed (Humphrey 12-4 test, Swedish Interactive Thresholding Algorithm, standard).

The WDT was performed under standard conditions. Patients fasted for 2 hours before it. After a baseline IOP measurement, the patient was asked to drink 1000ml of water in < 15 minutes. The time allowed for the actual water drinking in other studies has ranged from 5 to 15 minutes. We used 15 minutes to make the test as tolerable and comfortable for this elderly population as possible. Intraocular pressure was measured every 15 minutes for 1 hour after water drinking. Intraocular pressure increase was defined as the difference between the IOP peak and baseline. Intraocular pressure range was defined as the difference between the minimum and maximum IOPs measured during the WDT.
Results

There were no statistically significant differences found between the baseline characteristics of the 2 groups except in VA, which was slightly worse in the surgically treated patients (20/30 vs. 20/25 (Table 1).

<table>
<thead>
<tr>
<th>Table (1): Patient characteristics.</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Age</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Study eye</td>
</tr>
<tr>
<td>Right</td>
</tr>
<tr>
<td>Left</td>
</tr>
<tr>
<td>Baseline visual acuity</td>
</tr>
<tr>
<td>IOP (average of 3 visits before the WDT)</td>
</tr>
<tr>
<td>Mean deviation of visual field</td>
</tr>
</tbody>
</table>

Water drinking test results are shown in Figure 1 and Table II. A paired t test was used to compare IOP measurements. A highly significant difference was observed in mean IOP between the 2 groups at every 15-minute time point after water ingestion (p < 0.0001). Mean IOP during the WDT was 10.6 ± 2.1mmHg in the surgical group, compared with 15.1 ± 2.4mmHg in the medical group. The mean maximum IOP in the surgical group increased by 11.6% from baseline, compared with 54.9% in the medically treated group (p < 0.0001). Ranges of IOP during the WDT were 2.2 ± 1.2mmHg and 5.7 ± 1.8mmHg in the surgically and medically treated patients, respectively (p < 0.0001).
Table (2): Water drinking test in glaucoma patients.

<table>
<thead>
<tr>
<th>Time Point</th>
<th>Surgical</th>
<th>Medical</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>10.3 ± 2.2</td>
<td>11.1 ± 1.7</td>
<td>1.03</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>15 min.</td>
<td>10.6 ± 2.1</td>
<td>15.1 ± 2.4</td>
<td>4.89</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>30 min.</td>
<td>11.2 ± 2.4</td>
<td>16.7 ± 2.6</td>
<td>5.38</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>45 min.</td>
<td>11.3 ± 2.7</td>
<td>15.5 ± 3.2</td>
<td>3.47</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>60 min.</td>
<td>10.2 ± 2.5</td>
<td>14.4 ± 2.4</td>
<td>4.2</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Mean</td>
<td>10.6 ± 2.1</td>
<td>14.77 ± 2.1</td>
<td>4.78</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Max</td>
<td>11.6 ± 2.4</td>
<td>17.2 ± 2.3</td>
<td>5.84</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Min</td>
<td>9.4 ± 1.8</td>
<td>11.5 ± 1.6</td>
<td>3.02</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Range</td>
<td>2.2 (1.2)</td>
<td>5.7 (1.8)</td>
<td>5.6</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Figure (1): Intraocular pressure (IOP) of the surgical group compared with the medical group during the water drinking test.
Discussion

It has been well established that individuals with glaucoma have, on average, higher levels of IOP than those without the disease and that IOP is a dose-related risk factor. Additionally, there is some evidence to suggest that variations in IOP that may occur with the circadian rhythm are important in the development of VF damage in glaucoma. Higher peaks of IOP have been noted to affect both the extent and the rate of glaucomatous damage (Martinez et al., 2000).

Konstras et al. (2006) establishes that patients who have undergone successful trabeculectomy with mitomycin C with the same level of VF damage and baseline IOP as their medically controlled counterparts demonstrate less increase in IOP (1.3 vs. 6.2, respectively) and maintain lower mean IOP (10.7 vs. 14.6) in response to the WDT. Those with advanced glaucoma who had undergone trabeculectomy had a 24-hour range of IOP of $2.3 \pm 0.8$ ($2.2 \pm 1.3$ in our study, after WDT), whereas corresponding patients managed with maximal medical treatment had a range of $4.8 \pm 2.3$ ($5.6 \pm 1.9$ in our study). They observed that 37% of patients in the medically treated group had an increase in IOP to $>18$mmHg, whereas none of the corresponding surgical patients showed such an increase. Similarly, in our study 30% of the medically managed patients showed IOP elevation to $>18$mmHg after WDT, compared with no such IOP elevations occurring in the trabeculectomy group. In addition, our findings were that trabeculectomy patients showed a mean peak of 11.6% after the WDT, whereas the medically treated patients had a mean peak of 54.9% above baseline.

Mosaed et al. (2005) demonstrated that supine IOP measurements estimate peak nocturnal IOP better than sitting measurements in untreated glaucoma patients. This finding has the potential to be developed into a clinically useful investigation. However, further research is required to determine whether supine IOP measures are correlated to nocturnal IOP in patients with glaucoma who are on treatment.
A retrospective analysis done by Susanna et al. (2005) was conducted of VF and WDT data from 101 patients with glaucoma in clinical therapy, who were receiving treatment with the same topical medication in both eyes, and asymmetric VF defect. Eyes were classified according to mean deviation (MD) into "better" and contralateral "worse" eyes. Maximum mean difference in basal IOP was 2mmHg between both eyes. The peak IOP and fluctuation obtained with the WDT were compared between both groups. Eyes with worse MDs presented higher IOP peaks and fluctuation after water ingestion. This study demonstrates a lower capacity of eyes with worse glaucomatous lesion to respond to a stimulus that leads to a transitory elevation of IOP.

The mechanism proposed to explain the increase in IOP after water drinking is similar to that proposed to explain the increase in IOP that occurs in the recumbent or inverted head posture positions. Both are associated with increased episcleral venous pressure and a consequent decrease of outflow facility. Hence, a possible explanation for the increased IOP associated with the WDT is that medical treatments are not able to help an already compromised outflow facility present in glaucoma patients to a challenge by 1000ml of water ingestion, whereas a patent trabeculectomy provides a steady pathway for the drainage. It would be worthwhile to investigate whether smaller fluid challenges (i.e. 250ml) result in elevations in IOP in patients with glaucoma.

Conclusion
The present study suggests that a functioning trabeculectomy provides better IOP stabilization than medical management, despite seemingly stable IOPs in a standard clinical setting. Further research may provide insights into whether the elevation in IOP after the WDT provides a surrogate for IOP variations that occur in everyday situations and whether this stabilization of IOP with trabeculectomy translates into less functional damage.

References


