

# Evaluation of the intraocular pressure changes during micturition in patients with benign prostatic hyperplasia

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**Abstract.** – **OBJECTIVE:** To evaluate the effect of the Valsalva maneuver (VM) during micturition on intraocular pressure (IOP) in patients with benign prostatic hyperplasia (BPH).

**PATIENTS AND METHODS:** IOP were measured before and during micturition in uroflowmetry testing by Tonopen-Avia (Reichert Inc., NY, USA) in 35 eyes of 35 patients with BPH. International Prostate Symptoms Score (IPSS) questionnaire was used for quantification of BPH symptoms. The subjects were divided into two groups according to IPSS questionnaire: patients with low IPSS scores and patients with high IPSS scores.

**RESULTS:** The mean IOP before and during micturition in patients with BPH were  $15.26 \pm 4.39$  mmHg and  $16.23 \pm 4.43$  mmHg, respectively ( $p = 0.047$ ). When patients with BPH were assigned to two distinct groups according to the IPSS scores, IOP did not differ in patients with low IPSS scores ( $p = 0.590$ ), whereas mean IOP was significantly higher in patients with high IPSS scores ( $p = 0.007$ ).

**CONCLUSIONS:** The Valsalva maneuver, performed during micturition, can lead to significant IOP increase in patients with BPH, particularly in advanced disease.

*Key Words:*

Benign prostatic hyperplasia, Intraocular pressure, Uroflowmetry, Valsalva maneuver.

related with development and progression of glaucoma, such as systemic hypertension<sup>6</sup>, hypotension<sup>7</sup>, diabetes<sup>8,9</sup>, hypercholesterolemia<sup>10</sup>, migraine<sup>5</sup>, and other vasospastic diseases<sup>11</sup>, have been identified. In addition to these systemic factors, some reports suggest that IOP increases in certain types of exercises<sup>12,13</sup> possibly associated with Valsalva maneuver (VM), although there are various reports of a reduction in IOP after both dynamic<sup>14,15</sup> and isometric exercises<sup>16,17</sup>. Another condition associated with IOP increase due to VM occurs in wind instrument players, commonly misdiagnosed with normal-tension glaucoma<sup>18</sup>.

Benign prostatic hyperplasia (BPH), which affects 80% of men by age 80, is the most common cause of lower urinary tract symptoms in adult males<sup>19</sup>. The increase in life expectancy all over the world means a higher prevalence of BPH. Difficulty in micturition in BPH leads to VM in order to force urine flow through lower urinary tract. As glaucoma is a multifactorial disease that can be related to VM, in this study we aimed to evaluate the short-term variations in IOP during micturition in patients with BPH.

## Patients and Methods

We enrolled 35 patients with BPH between ages 50 and 86. This prospective study was conducted in accordance with the tenets of the Declaration of Helsinki and with the approval of Ethics Committee of Onsekiz Mart University School of Medicine. Informed consent was obtained from all participants. All of the participants completed the International Prostate Symptoms Score (IPSS) questionnaire used for quantification of BPH symptoms and received urolog-

## Introduction

Glaucoma describes a group of ocular disorders with multi-factorial etiology united by a clinically characteristic intraocular pressure-associated optic neuropathy<sup>1</sup>. Glaucoma is not solely associated with elevated intraocular pressure (IOP). If this were the case, successful lowering of IOP would stop the progression of the glaucomatous damage in all types of the disease. This is normally not the case<sup>2-5</sup>. Numerous potential systemic risk factors

**Table I.** Intraocular pressure measurements before and during micturition in patients with benign prostatic hyperplasia.

|              | IOP before micturition<br>Mean ± SD (range) | IOP during micturition<br>Mean ± SD (range) | p-value |
|--------------|---|---|---------|
| IOP (n = 35) | 15.26 ± 4.39<br>(10-26)                     | 16.23 ± 4.43<br>(9-25)                      | 0.047   |

IOP, intraocular pressure; p-value for Wilcoxon Signed Ranks Test.

ical examinations. They also underwent ophthalmic examinations, including best-corrected visual acuity, refractive error, slit-lamp evaluation, extraocular movements, intraocular pressure measurement using Tonopen-Avia (Reichert Inc., NY, USA) and fundoscopy. Only the right eyes of each patient were selected for the study.

Patients were excluded if they had refractive error more than ±4.00 diopters, astigmatism greater than ±2.00 diopters, glaucoma, cup-disc ratio asymmetry, any kind of eye infection, or used any systemic or topical medications that may affect IOP, as well as any medication for BPH.

IOP measurements were done during uroflowmetry in the standing position, which were carried out between 9 a.m. and noon. As the extra fluid intake may lead to increase in IOP, patients were asked not to intake extra fluid before the measurements. The baseline IOP and the second one during the uroflowmetry were obtained in right eyes of the patients using Tonopen-Avia (Reichert Inc., NY, USA) after instillation of proparacaine hydrochloride 0.5% (Alcaine, Alcon, Turkey). The tonometer averages 10 successful readings and displays the mean and SD. Micturition frequency and time were recorded.

### Statistical Analysis

SPSS software version 20.0 (SPSS, Inc., Chicago, IL, USA) was used for statistical analyses. Wilcoxon signed-rank tests were used to determine whether there are differences between baseline IOP and the measure during the uroflowmetry. Subgroup analysis also carried out dividing individuals as patients with mild symptoms (IPSS <8) and with moderate or severe symptoms (IPSS ≥8). A “p” value less than 0.05 was considered statistically significant.

### Results

We enrolled 35 eyes of 35 patients with BPH with a mean age of 63.1±9.0 years (range; 50 to 86 years).

The mean micturition frequency in patients with low and high IPSS scores were 10.67±1.32 and 12.81±2.40, respectively ( $p = 0.042$ ). The mean micturition time in patients with low and IPSS scores were 153.67±15.98 and 173.65±15.09 min ( $p = 0.02$ ), respectively.

The mean IOP value was significantly higher during micturition compared to baseline ( $p=0.047$ ) (Table I). The mean IOP change was 0.97±2.84 mmHg (range -5 to 6 mmHg). The IOP increased in 24 (68.6%) of 35 eyes, and decreased in 11 eyes (31.4%). The mean IOP increase in these 24 eyes was 2.58±1.50 mmHg (range 1 to 6 mmHg). The mean IOP decrease in these 11 patients was -2.55±1.57 mmHg (range -1 to -5 mmHg).

Patients were classified into 2 groups based on their IPSS scores. There were 9 patients with low and 26 patients with high IPSS scores, and the 2 groups were similar in terms of age and baseline IOP ( $p=0.59$  and 0.14, respectively). The change in IOP during micturition was not significant in patients with low IPSS scores ( $p=0.59$ ), whereas mean IOP during micturition in patients with high IPSS scores was significantly higher than that as baseline ( $p=0.007$ ) (Table II).

The IOP increased in 20 (76.9 %) eyes, whereas the IOP decreased in 6 (23.1%) eyes during micturition in patients with high IPSS scores. The mean IOP increase in the 20 eyes was 2.60±1.60 mmHg (range 1 to 6 mmHg). The mean IOP decrease in the 6 eyes was -2.17±1.60 mmHg (range -1 to -5 mmHg).

### Discussion

The Valsalva maneuver (VM) is habitually performed during a moderately forceful attempt with exhalation against a closed airway to increase intrathoracic pressure. VM occurs during daily activities such as coughing, lifting heavy objects and vomiting. Primarily, according to the change of systemic arterial blood pressure, the VM is divided into four phases<sup>20</sup>: Phase 1, a transient increase in pressure in the thoracic aorta

**Table II.** Intraocular pressure measurements before and during micturition in patients with low and high IPSS scores.

|   | IOP before micturition<br>Mean $\pm$ SD (range) | IOP during micturition<br>Mean $\pm$ SD (range) | <i>p</i> -value |
|---|---|---|-----------------|
| Patients with Low IPSS scores (n = 9)   | 17.00 $\pm$ 4.36<br>(13-26)                     | 16.44 $\pm$ 4.22<br>(11-25)                     | 0.59            |
| Patients with High IPSS scores (n = 26) | 14.65 $\pm$ 4.32<br>(10-24)                     | 16.15 $\pm$ 4.58<br>(9-24)                      | 0.007           |

IPSS, International prostate symptoms score; IOP, intraocular pressure; *p*-value for Wilcoxon Signed Ranks Test.

due to compression of the aorta; Phase 2, raised intrathoracic pressure reduces venous return, resulting in decreasing aortic pressure and increasing heart rate; Phase 3, it occurs at the end of a forceful exhalation resulting in a drop in intrathoracic pressure; and Phase 4, arterial blood pressure rises transiently as a result of increased venous return. Hence, the increase of intrathoracic pressure and the compression of intrathoracic veins during a VM venous pressure rise is transmitted through jugular, orbital, and vortex veins to the choroid, leading to vascular engorgement, an increase in choroidal volume resulting in an increase in IOP<sup>21,22</sup>.

In literature, the effect of VM on IOP was evaluated during certain types of exercises<sup>12</sup>, while playing wind instruments<sup>18,23</sup>, and exhaling into a tube connected to a mercury manometer<sup>24,25</sup>. The IOP increases were reported during weightlifting with and without subjects holding their breath,  $+4.3 \pm 4.2$  and  $+2.2 \pm 3.0$  mmHg, respectively<sup>12</sup>. A patient's query about whether his trumpet playing had contributed to his glaucoma led Schuman et al<sup>18</sup> to study whether wind instrument playing contributed to the IOP increase. They concluded high and low resistance wind musicians experience a transient rise in their IOP while playing their instruments. Thus, the cumulative effects of long-term intermittent IOP elevation during wind instrument playing may result in glaucomatous damage, which could be misdiagnosed as normal-tension glaucoma. In a study investigating the effect of VM on IOP while exhaling into a tube connected to a mercury manometer, Lanigan et al<sup>26</sup> found a significant increase in mean IOP of 7.2 mmHg during the VM. Using similar methodology, Brody et al<sup>24</sup> and Aykan et al<sup>25</sup> observed a statistically significant increase in IOP of  $10.2 \pm 4.0$  mmHg (range 2-18) and  $2.6 \pm 2.9$  mmHg (range -2.5 to 10.4), respectively.

To the best of our knowledge, the current study is the first study to identify the effect of VM during micturition on IOP measurements in patients

with BPH. We observed a greater IOP increase in patients with high IPSS scores. The greater micturition frequency, higher micturition time accompanying the greater need to VM during micturition and greater intrathoracic pressure in patients with high IPSS scores may cause greater IOP increase compared with patients with low IPSS scores. In the current study, the mean IOP increase during VM is similar with some studies<sup>12,22,25</sup> but the increase is smaller than others<sup>24,26</sup>. The most probable reason for relatively small increases in IOP is difficulty in standardizing and quantifying the VM during micturition in participants. Although we asked the participants to strain during micturition, some patients might not fully achieve adequate VM. The phase III responses of VM are intensified in the standing position<sup>27</sup>. In the present study, the fall in IOP during VM in some eyes may be attributed to an augmented phase III response of VM during standing. Aykan et al<sup>25</sup> reported that the mean IOP decrease was -1.3 mmHg (range -0.4 to -2.5 mmHg) in nine eyes (16.4%) during the VM. In the present study, the mean IOP decrease observed in 11 (31.4%) was  $2.55 \pm 1.57$  mmHg (range -1 to -5 mmHg), which are both higher in incidence (number of eyes) and IOP change amplitude. Similarly, the IOP increase in the other patients may be found to be lower than that in other studies due to the effect of standing on VM.

We would like to underline that future studies with larger sample sizes, electrocardiographic monitoring and urodynamic testing for standardization, and quantification of VM during micturition in glaucoma and non glaucomatous patients are needed.

## Conclusions

A significant IOP increase was observed in BPH patients with high IPSS scores. It should be considered that the cumulative effects of long-term intermittent IOP increases during micturi-

tion in patients with BPH may play a role in long term damage to the optic nerve. Further studies are needed to elucidate whether the IOP variations during micturition in glaucoma patients with BPH alter glaucoma progression.

### Conflict of Interest

The Authors declare that they have no conflict of interests.

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