Retrobulbar hemodynamic parameters in men and women with open angle glaucoma

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Abstract

Background/Aim. Several factors may have influence on systemic circulation. Additionally, peripheral circulation also demonstrates sex differences, in young women presenting significantly lower finger blood flow in comparison to men of the same age, a finding that disappears in women after menopause. The aim of this study was to compare the retrobulbar hemodynamic parameters measured by means of color Doppler imaging in women and men with open-angle glaucoma and elevated intraocular pressure.

Methods. A total of 52 eyes from 52 open-angle glaucoma (OAG) patients, with elevated intraocular pressure (IOP), were included in this cross-sectional study. Peak-systolic velocity (PSV), end-diastolic velocity (EDV), and Pourcelot resistivity index (RI) were assessed in the ophthalmic artery (OA), central retinal artery (CRA), and posterior ciliary arteries (PCA). IOP was measured both with Goldmann Applanation tonometer (GAT) and with the dynamic contour tonometer (DCT), three times respectively. Ocular pulse amplitude (OPA) appeared during the DCT measurement.

Results. The retrobulbar hemodynamic parameters did not show any difference between men and post-menopausal women.

Conclusion. The results of our study did not find any difference between sexes in patients with open-angle glaucoma and elevated intraocular pressure.

Key words: glaucoma, open-angle; men; women; intraocular pressure; ischemia; eye; diagnosis.

Introduction

The term glaucoma covers a wide range of chronic, multifactorial, and progressive optic neuropathies in which elevated intraocular pressure (IOP) is an important risk factor 1–3.

Nevertheless, there is increasing evidence suggesting that ocular blood flow disturbances are involved both in the...
pathogenesis of glaucoma \(^4\)–\(^9\) and in progression of glaucomatous damage \(^10\)–\(^12\).

Several factors may have influence on systemic circulation. Additionally, peripheral circulation also demonstrates sex differences, in young women presenting significantly lower finger blood flow in comparison to men of the same age, a finding that disappears in women after menopause \(^13\)–\(^14\).

Many different methods are used to measure directly or calculate indirectly the ocular hemodynamic parameters in humans. Among them, the color Doppler imaging (CDI) combines B-scan grey scale imaging of tissue structure, color representation of blow flow based on Doppler shift and pulsed Doppler measurement of blood flow velocities. This method is used, in ophthalmology, to measure blood flow velocities in retrobulbar vessels \(^6\)–\(^15\)–\(^17\).

The aim of this study was to compare the retrobulbar hemodynamic parameters measured by means of color Doppler imaging in women and men (age 50 and more) with open-angle glaucoma and elevated intraocular pressure.

**Methods**

This prospective cross-over study was conducted on consecutive recruited patients who met inclusion and exclusion criteria, seen at the University Eye Clinic, Clinical Center of Serbia, from December 2009 to December 2010.

This study was approved by the Ethics Committee of the University Eye Clinic, Clinical Center of Serbia, and was conducted in accordance with Good Clinical Practice and the tenets of the Declaration of Helsinki. The patients signed an informed consent form before inclusion.

All the participants were required to meet the following inclusion criteria: age equal to or higher than 50 years, clinical diagnosis of open-angle glaucoma in early to moderate stage \(^15\), IOP equal or higher than 25 mmHg without treatment and willingness to comply with the investigators and protocol indications.

The patients were excluded if they had other type of glaucoma different than open-angle glaucoma, previous treatment with ocular filtering surgery, the history of previous refractive surgery, any hormonal therapy, acute myocardial infarction or stroke within the past three month, diabetes, the history of progressive retinal or optic nerve disease of any cause, and asthma or any other obstructive pulmonary disease.

All the patients underwent complete ophthalmologic examination, Goldmann applanation (GAT) (Goldmann tonometer; Haag Streit AG, Koeniz, Switzerland) and dynamic contour tonometry (DCT) (Dynamic Contour tonometer; Ziemer Ophthalmic Systems, Port, Switzerland), central corneal thickness (CCT) with ultrasound pachymetry (Palm Scan AP 2000, Ophthalmic Ultrasound, Micro Medical Devices, Inc., Clabasas, CA, USA), visual field examination (Humphrey VFA, Carl Zeiss Meditec) and confocal scanning laser retinal tomography (HRT II) (Heidelberg Engineering Inc. Heidelberg, Germany). IOP was measured both with GAT and DCT, three times respectively. After a decrease of elevated IOP (IOP < 20 mmHg), both by medications or by surgery, we repeated GAT and DCT. Ocular pulse amplitude (OPA) appeared during the DCT measurement.

Hemodynamic parameters were measured in the ophthalmic artery (OA), central retinal artery (CRA), and posterior ciliary arteries (PCA). Peak systolic (PSV) and end-diastolic (EDV) velocities were measured. Peak systolic velocity and EDV were used to calculate the Poucelot resistivity index (RI) using the following equation: \(RI = \frac{PSV - EDV}{PSV}\). All color Doppler imaging (CDI) examinations (model Antares; Siemens, Munich, Germany) were performed by the same experienced observer, who was masked to the diagnosis. Evaluations of blood pressure and radial pulse were obtained in a supine position after 10 min of rest. Systolic (SBP) and diastolic blood pressure (DBP) were measured in the upper right arm using a mercury sphygmomanometer and heart rate (HR) was measured by palpation of the radial pulse. These parameters were obtained every 10 min, during Doppler examination.

Descriptive statistics (mean and standard deviation) and 95% confidence intervals (95% CIs) were used to report demographic and ocular baseline characteristics. Data were tested for normal distribution using a D’Agostino-Pearson test \(^20\). As data were normally distributed, a two-tailed, independent samples Student’s \(t\)-test was used to evaluate the IOP and the hemodynamic parameters by intergroup comparisons. Because of the large number of tests, simultaneous inference using the Bonferroni correction was used to correct the \(p\) -value (\(a/9\)). Statistical significance was accepted for \(p < 0.0055\).

Statistical analysis was performed using MedCalc11.5.1.0 (MedCalc software, Mariakerke, Belgium).

**Results**

Of the 60 patients who were screened, 52 (22 women and 30 men) fulfilled the respective demands of the inclusion and exclusion criteria. The mean (SD) [95% confidence interval (CI)] age was 70.7 (9.9) [66.6 to 74.8] and 68.3 (12.9) [63.7 to 72.9] years in women and men, respectively. The main clinical and demographic characteristics are summarized in Table 1.

Regarding the retrobulbar hemodynamic parameters, there were no significant differences between women and men (Table 2).

**Discussion**

The results of our study suggested no differences in the retrobulbar hemodynamic parameters between the women of 50 years and more and age-matched men with open-angle glaucoma and elevated IOP.

There are relatively few studies that evaluate possible differences in the retrobulbar hemodynamic parameters between sexes in open-angle glaucoma patients.

In a cross sectional study Harris et al. \(^21\) evaluated the influence of age on retrobulbar circulation assessed with color Doppler. Based on the results of this study, it seems
that women and men show different behavior. In women not receiving estrogen replacement therapy older age is associated with reduced EDV, constant PSV, and elevated resistivity index in posterior ciliary arteries. Although our study did not evaluate the impact of age on the retrobulbar hemodynamic, we did not find any difference between men and women in these parameters.

It is well-known that peripheral and central circulations respond differently to the status of sexual hormones. Harris-Yitzhak et al. examined the role that estrogen may play on retrobulbar arteries. This study reports that estrogen-replacement therapy in postmenopausal women apparently helps to reduce vascular resistance distal to the ophthalmic artery to the levels matching those of young women. Similarly, Centofanti et al. and Kavroulaki et al. observed higher choroidal blood flow in premenopausal women. In our study women did not take estrogen replacement therapy and that fact might justify the lack of differences in retrobulbar circulation among them.

In our study we did not evaluate hormonal involvement in men and women, nor its correlation with retrobulbar circulation. Hormonal therapy was one of the exclusion criteria for our study.

**Conclusion**

The results of our study show no difference between sexes in patients with open-angle glaucoma and elevated intraocular pressure. Further investigations are needed in this field to clarify these results.

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**Table 1**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Women (n = 22)</th>
<th>Men (n = 30)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>70.7 (9.9)</td>
<td>68.3 (12.9)</td>
<td>0.367</td>
</tr>
<tr>
<td>CCI (μ)</td>
<td>558.5 (36.3)</td>
<td>550.3 (40.3)</td>
<td>0.447</td>
</tr>
<tr>
<td>IOP (mm Hg)</td>
<td>30.8 (7.9)</td>
<td>31.2 (9.2)</td>
<td>0.850</td>
</tr>
<tr>
<td>OPA (mm Hg)</td>
<td>4.2 (1.4)</td>
<td>4.1 (1.2)</td>
<td>0.515</td>
</tr>
<tr>
<td>MD (dB)</td>
<td>-3.2 (3.3)</td>
<td>-2.8 (3.2)</td>
<td>0.681</td>
</tr>
<tr>
<td>PSD (dB)</td>
<td>2.6 (1.9)</td>
<td>2.6 (2.1)</td>
<td>0.958</td>
</tr>
</tbody>
</table>

SD – standard deviation; 95% CI – 95% confidence interval; CCI – central corneal thickness; IOP – intraocular pressure; OPA – ocular pulse amplitude; MD – mean defect; PSD – pattern standard deviation.

*p*-values were calculated comparing the parameters at baseline between the two study groups (one-way ANOVA test); *p*-values were considered statistically significant if lower than 0.05.

**Table 2**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Women (n = 22)</th>
<th>Men (n = 30)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSV OA</td>
<td>54.9 (29.9)</td>
<td>57.5 (21.4)</td>
<td>0.733</td>
</tr>
<tr>
<td>EDV OA</td>
<td>16.6 (11.9)</td>
<td>12.4 – 22.6</td>
<td>0.785</td>
</tr>
<tr>
<td>RI OA</td>
<td>0.72 (0.12)</td>
<td>0.67 – 0.75</td>
<td>0.903</td>
</tr>
<tr>
<td>PSV CRA</td>
<td>24.7 (9.5)</td>
<td>28.6 (10.2)</td>
<td>0.266</td>
</tr>
<tr>
<td>EDV CRA</td>
<td>7.3 (2.4)</td>
<td>9.9 (3.9)</td>
<td>0.377</td>
</tr>
<tr>
<td>RI CRA</td>
<td>0.68 (0.14)</td>
<td>0.63 – 0.71</td>
<td>0.878</td>
</tr>
<tr>
<td>PSV PCA</td>
<td>27.7 (12.9)</td>
<td>33.1 (13.3)</td>
<td>0.173</td>
</tr>
<tr>
<td>EDV PCA</td>
<td>9.0 (3.7)</td>
<td>9.4 (4.5)</td>
<td>0.713</td>
</tr>
<tr>
<td>RI PCA</td>
<td>0.64 (0.13)</td>
<td>0.62 – 0.74</td>
<td>0.294</td>
</tr>
</tbody>
</table>

SD – standard deviation; 95% CI – 95% confidence interval; PSV – peak systolic velocity; EDV – end-diastolic velocity; RI – resistivity index; OA – ophthalmic artery; CRA – central retinal artery; PCA – posterior ciliary artery.

Unpaired Student’s *t*-test (*p*-values were considered statistically significant if lower than 0.05).
REFERENCES


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