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GENERAL ARTICLE

THE ROLE OF SYSTEMIC BLOOD PRESSURE IN GLAUCOMA PROGRESSION

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Abstract

The present paper aims to highlight the role of arterial hypotension in the progression of glaucoma. The data analyzed in this study was collected in a prospective manner for a period of one year, from september 2013 to august 2014. It includes newly diagnosed glaucoma patients treated with prostaglandin analogues and who have presented within normal range values of intraocular pressure during the study.

In spite of good control of intraocular pressure, there was recorded a progression of glaucoma lesions documented using the visual field . All patients were evaluated through 24 h outpatient holter monitoring of systemic blood pressure (BP) and were consequently divided into three groups:

- Group A- non-dipper (within normal range of both diurnal and nocturnal BP values and no significant drop during the night)
- Group B- dipper (patients with nocturnal hypotension recording BP drops of more the X mmHg)
- Group C- patients with arterial hypertension (defined as diurnal values of more than 150 mmHg for systolic BP and 110 mmHg for dyastolic BP)

After through statistical analysis of the patients data, we noticed that the most important progression of glaucoma changes objectified by visual field and OCT examinations was recorded in group B, which illustrates the importance of careful monitoring and strict control of blood pressure in order to eliminate this risk factor in the progress of glaucoma.

Key words: blood pressure, glaucoma, progression, risk factor, dipper, visual field, OCT

Introduction

Although the intraocular pressure is considered firstly the main risk factor in the emerging and evolution of glaucoma and, secondly, the only parameter which can be treated, there is certain evidence in literature that suggests that glaucoma can advance in spite of normal values of intraocular pressure [**1**]. An important number of clinical studies conducted on large population groups pointed out the role

of several risk factors in the patogenesys of glaucoma. One of the most important risk factor is the systemic blood pressure and the ocular perfusion pressure. Although, in clinical practice, the direct blood flow cannot be viewed directly in the eye, clinicians can measure the glaucomatous patients' blood pressure and their intraocular pressure in order to calculate later the eye's ocular perfusion pressure and quantify the microvascular modifications.

The main source of vascularization for the optic nerve is the posterior ciliary artery. The temporal region of the optic disk can be vascularized by branches of cilioretinal artery [**4**]. The prelaminar and laminar regions receive oxygen and nutrients from the short posterior ciliary arteries which have straight branches and form the scleral circulary arterial anastomosis and then the Zinn-Haller arterial ring. The retrolaminar region is vascularized by short posterior ciliary arteries and by branches of the central retinal artery through recurrent pial arteries. The intracranial part of the optic nerve is vascularized by the oftalmic artery and the Calos Body's artery. The orbital part of the optic nerve is vascularized only by the oftalmic artery. The posterior ciliary artery, posterior short ciliary arteries, the central retinal artery and the cilioretinal artery are branches of the oftalmic artery, the latter being branch of the internal carotid artery [**7**].

After 24 h continuous recording of the blood pressure for glaucoma patients under correct therapy and without significant intraocular pressure fluctuations, there was observed a progression of lesions on the visual field examinations, especially for patients who presented lower than normal values of nocturnal blood pressure. A higher incidence of optic disk hemorrhages was reported in patients with nocturnal hypotension.

Between the ocular perfusion pressure and open angle glaucoma, it was proven that there is a certain association, due to the fact that intraocular pressure is part of ocular perfusion pressure [**3**].

The notion of „dipper" is defined as the reduction of blood pressure during night with more than 10% in comparison with the values measured during daytime. Patients who present a reduction of less than 10% of the nocturnal blood pressure are considered nondippers [**2**].

Objective

The purpose of this study is to review the role of blood pressure in the progression of glaucoma and to highlight the importance of vascular factors (cerebral hypoperfusion and hyperperfusion) in the evolution of glaucoma.

Materials and methods

The present paper consists of a clinical, prospective study, observational and interventional for one year period, that includes newly diagnosed glaucomatous patients in "Nicolae Malaxa" Clinical Hospital. The positive diagnosis was established by clinical and paraclinical examinations and the selected patients had treatment with prostaglandin analogues. In this study, the patients' blood pressure was evaluated through 24 h outpatient holter monitoring with the help of the cardiology department. There are three groups into discussion:

- Group A- nondipper (without hypotension or hypertension)
- Group B- dipper (patients with nocturnal hypotension)
- Group C- patients with hypertension

The patients were all monitorized through regular checks every 3/6 months by clinical examination (anterior pole, fundus retinoscopy) and laboratory tests (gonioscopy, Goldmann aplanotonometry, pachimetry, retinofotography, computerized perimetry and OCT).

All patients were investigated through Doppler ultrasound velocimetry for cervical arteries to eliminate those who presented significant common carotid artery, internal carotid artery stenosis or stenosis of common carotid artery's fork, which can represent additional risk factors in the progression of glaucoma (9). This pathology can influence the obtained results.

Results

The clinical study is conducted in a prospective, observational and interventional manner, for a period of one year (from September 2013 to August 2014), held at "Nicolae Malaxa" Clinical Hospital, including 45

patients (90 eyes) with newly diagnosed open angle glaucoma through clinical and paraclinical examinations and receiving treatment with prostaglandin analogues.

The patients were divided into three homogeneous groups in terms of age and sex, with no other ocular or significant systemic pathologies for the one studied:

- Lot A- 14 patients diagnosed with POAG who do not have hypertension or hypotension (nondipper).
- Lot B- 13 patients diagnosed with glaucoma who have nocturnal hypotension (dipper).
- Lot C- 12 patients diagnosed with glaucoma who have hypertension. (**Fig. 1-4**)

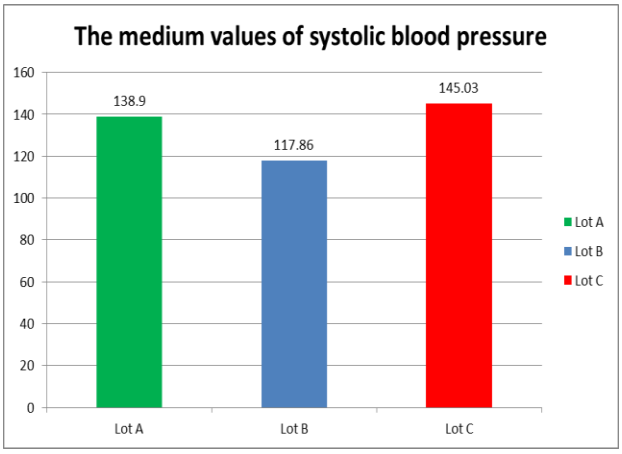

Fig. 1 The medium values of systolic blood pressure

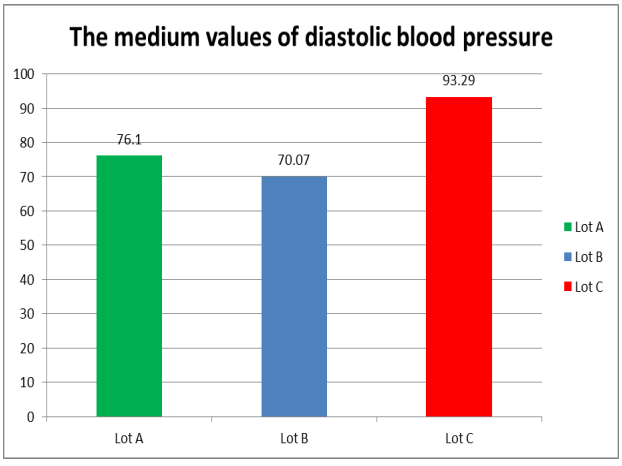

Fig. 2 The medium values of diastolic blood pressure

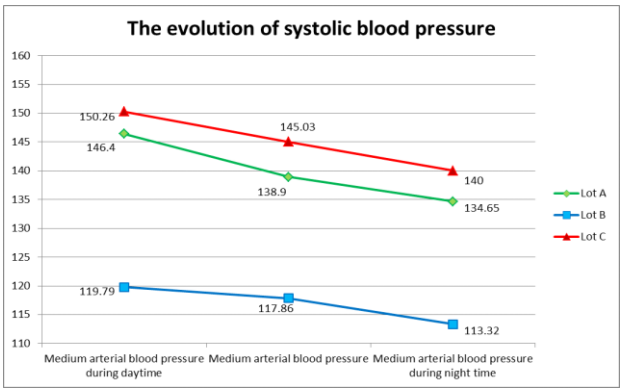

Fig. 3 The evolution of systolic blood pressure

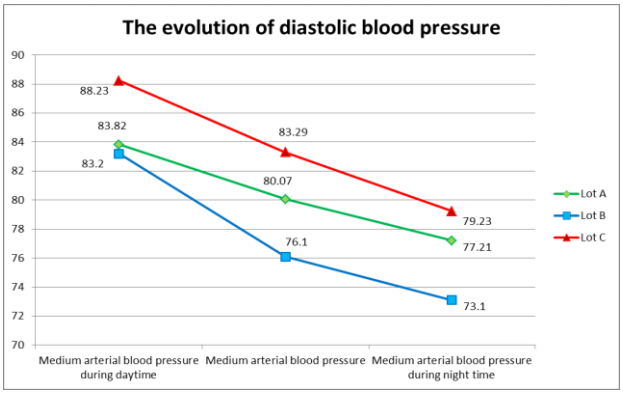

Fig. 4 The evolution of diastolic blood pressure

At the beginning of the study, the visual field analysis, through the parameter called mean deviation (MD) showed the following: the most important visual field modification illustrated by the smallest medium value of the mean deviation was recorded in lot B, followed by lot A and then lot C. (**Fig. 5**)

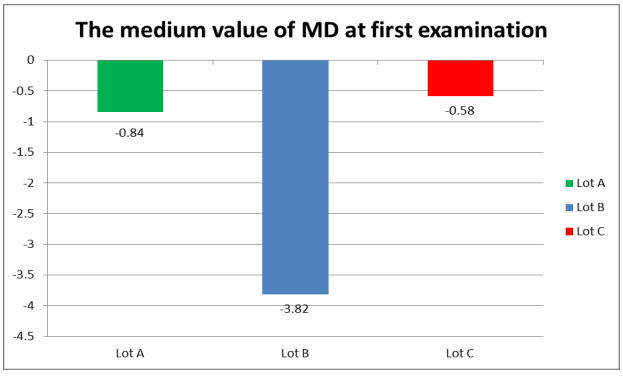

Fig. 5 The medium value of MD at first examination

At six months after therapy start, the medium value of MD recorded a much lower decrease than the initial value, especially in lot B. (**Fig. 6**)

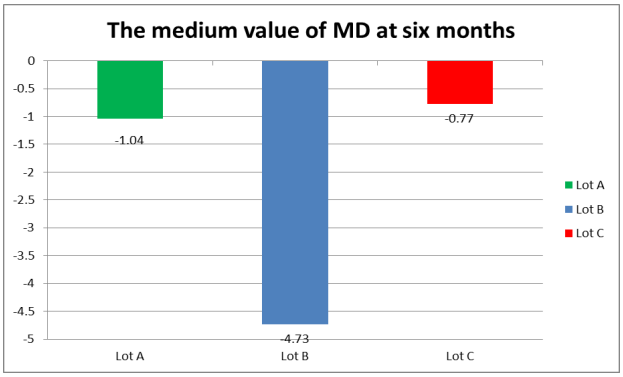

Fig. 6 The medium value of MD at six months

After one year (or at the end of the study), the value of MD decreases continuously in all three lots. The differences between the final and initial values of MD being statistically significant in lot B. (**Fig. 7-8**)

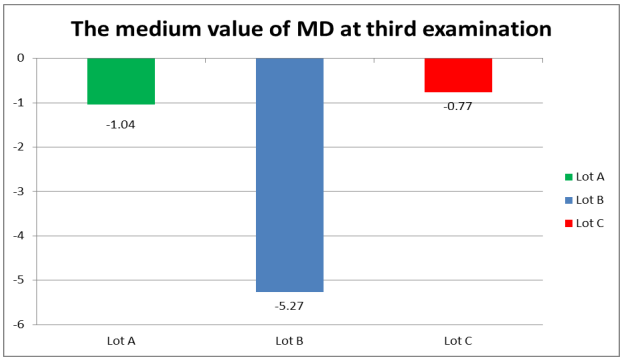

Fig. 7 The medium value of MD at third examination

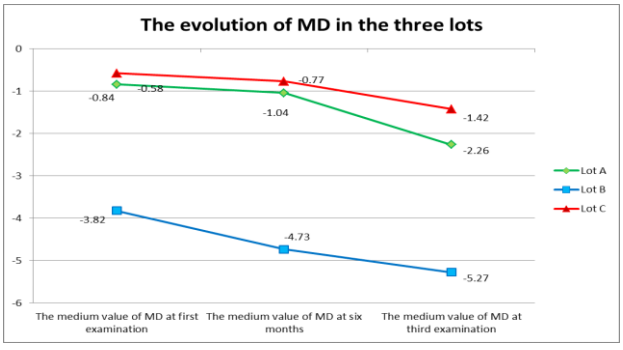

Fig. 8 The evolution of MD in the three lots

At the beginning of the study, the analysis of the visual field through the parameter called PSD (Pattern Standard Deviation) showed the following: the most important modifications of visual field, illustrated by the highest medium value of PSD, were recorded in lot B. (**Fig. 9**)

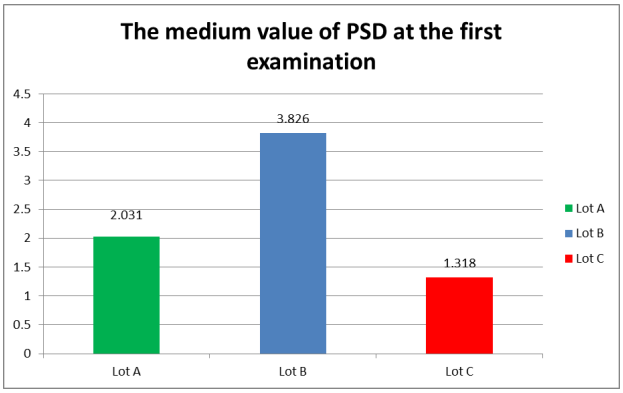

Fig. 9 The medium value of PSD at the first examination

After six months, the medium value of PSD recorded a more rapid increasing rate than the initial value in all lots, the most important value corresponding to the hypotension patients (lot B) followed by the witness lot (lot A). (**Fig. 10**)

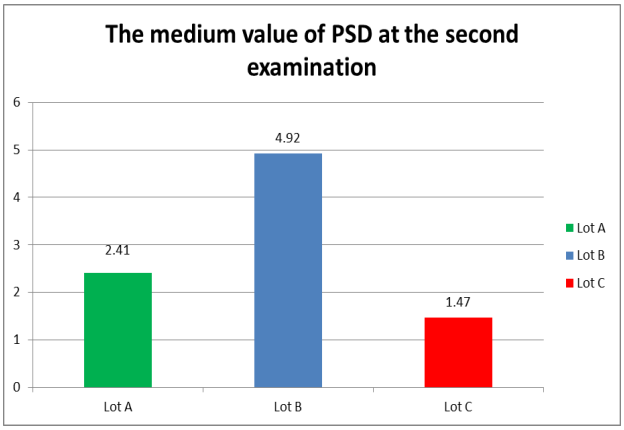

Fig. 10 The medium value of PSD at the second examination

After one year, the medium value of PSD continues to increase in all three lots, the differences between the final and the initial values being significantly higher in the same lot B and lower in the other two. (**Fig. 11-12**)

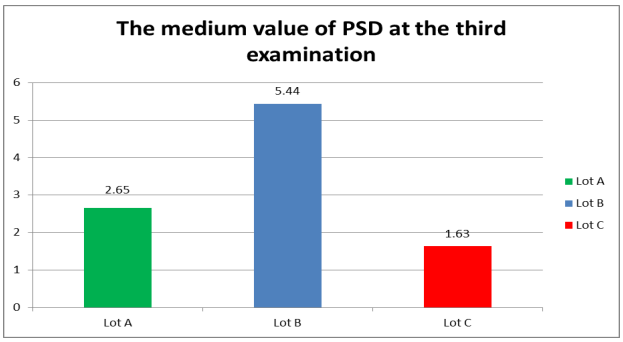

Fig. 11 The medium value of PSD at the third examination

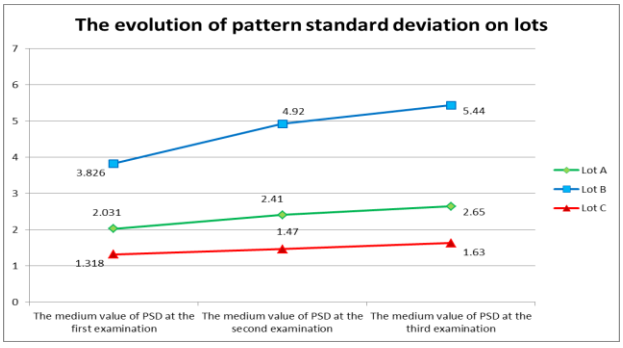

Fig. 12 The evolution of pattern standard deviation on lots

The structural modifications are highlighted by the vertical cup/disk ratio and its changes during the study, and also by the ganglionar cell loss with decreased thickness of the nerve fiber layer. The highest cup/disk ratio corresponded at the time of diagnosis to lot B, followed by lot A and C. (**Fig. 13**)

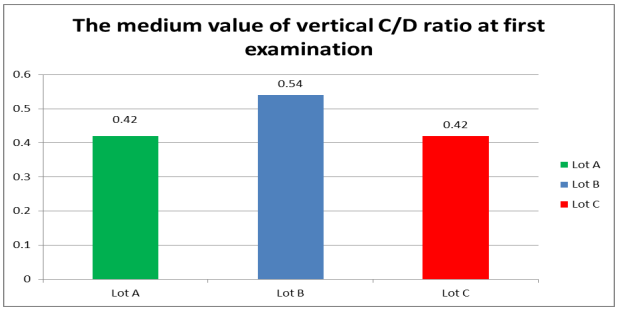

Fig. 13 The medium value of vertical C/D ratio at first examination

The review on OCT after one year showed increased values of the C/D ratio in all three groups, the highest value being recorded to the hypotensive patients' group (lot B). (**Fig. 14-15**)

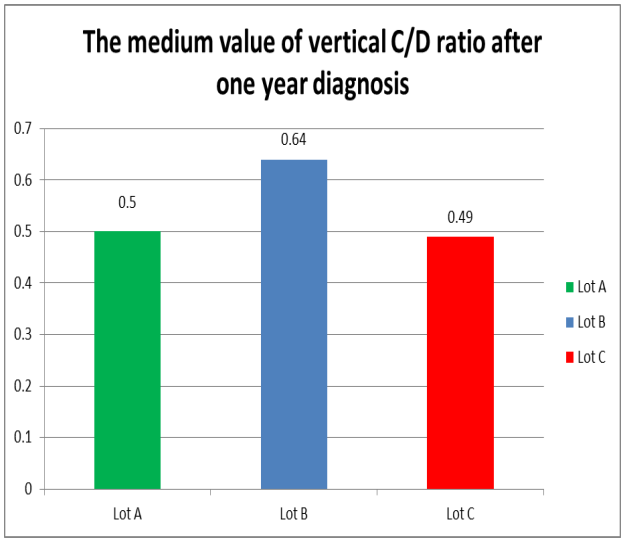

Fig. 14 The medium value of vertical C/D ratio after one year diagnosis

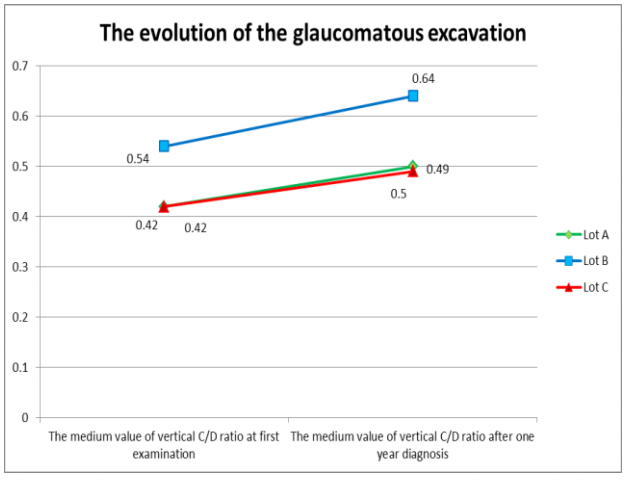

Fig. 15 The evolution of the glaucomatous excavation

The glaucomatous pathology affecting retinal nerve fibers is emphasized by changes in RNFL. At the beginning of the study, the highest values of RNFL were recorded for patients in lot

B. Lower levels were recorded in lots A and C. (**Fig. 16**)

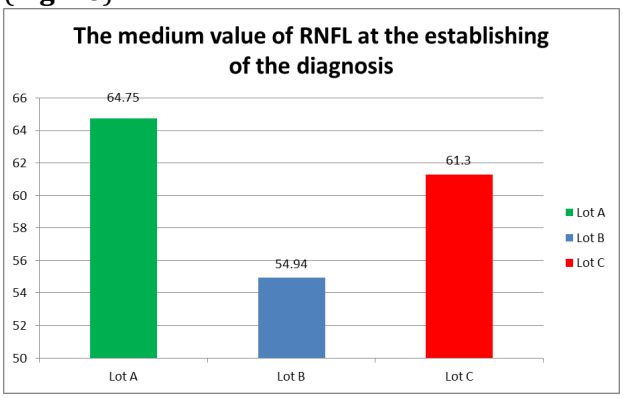

Fig. 16 The medium value of RNFL at the establishing of the diagnosis

After one year the same distribution of the medium values of RNFL is kept. The biggest loss of nerve fibers is found in lot A, followed by lots C and B. (**Fig. 17-18**)

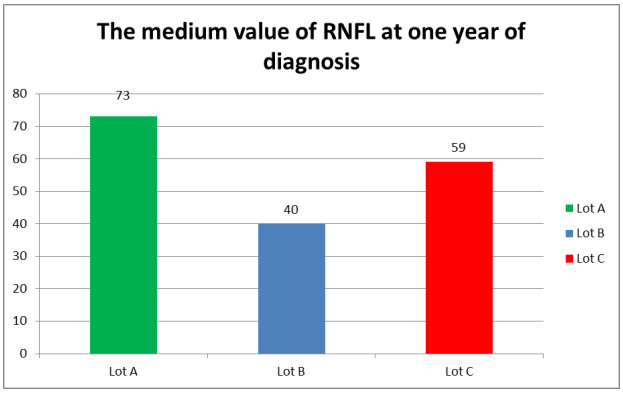

Fig. 17 The medium value of RNFL at one year of diagnosis

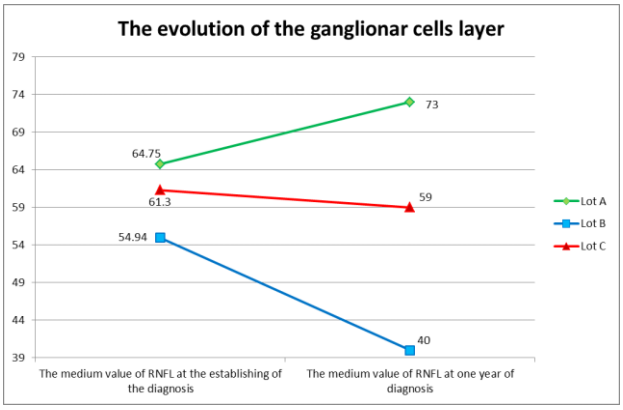

Fig. 18 The evolution of the ganglionar cells layer

Conclusions

It is known that glaucoma is a major cause of irreversible blindness worldwide. This work is one of the more typical glaucomatous pathology, seeking to elucidate the theory of the influence of nocturnal hypotension in the progression of glaucoma.

We have conducted an observational analysis and then compared our data to others found in literature; the results allowed us to formulate the following conclusions:

The main deviation (MD) is the most important parameter for analyzing the progression of glaucomatous damage. According to our findings, it appears that even from the time of diagnosis, values in the dipper group were significantly lower compared to patients who had hypertension and the ones from the nondipper group.

The pattern standard deviation (PSD) is another important parameter in glaucoma progression analysis. Analyzing the average values of the PSD at baseline showed greater values in the dipper group compared to the others. Finally, at the end of the follw-up period, we noticed a higher increase in the PSD value for the same lot, followed by lot A and then C.

The structural changes on the OCT, cuantified by the value of vertical C/D ratio, was highest in lot B.

The glaucomatous pathology affecting nerve fibers was distinguished by changes in RNFL thickness in the same lot B.

Under the influence of risk factors, the nocturnal hypotension recorded major changes in the progression of glaucoma in the dipper lot by analyzing the structural changes highlighted on the OCT and functional analysis of the visual fields.

According to the results obtained in the present study, we can definitively state that nocturnal hypotension is a major risk factor in the progression of glaucoma. The ocular neuroprotection and improved hemodynamics represent future therapeutic options of substantial importance.

Discussions

The paper aims to highlight the role of vascular factors in the development of glaucoma

and certify the importance of 24 h continous Holter monitoring of blood pressure for the glaucomatous patients. The work opens new premises of research studies with consequent demonstration of the importance of neuroprotection in treatment for glaucoma. The work is consistent with the literature studies like Graham's who affirmed in one of his studies that nocturnal hypotension can be an additional risk factor in glaucoma [**2**]. Also, Mary E. Charlson concluded that cumulative nocturnal hypotension predicts visual field loss and that low values of the nocturnal blood pressure, either occurring spontaneously or as a result of medication teraphy, may lead to worsening of visual field defects [**13**].

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13. Mary E. Charlson , MD Carlos Gustavo de Moraes, MD Alissa Link, MPH Martin T. Wells, PhD, Gregory Harmon, MD Janey C. Peterson, Ed D Robert Ritch, MD Jeffrey M. Liebmann, MD Received: Nocturnal Systemic Hypotension Increases the Risk of Glaucoma Progression December 31, 2013.