# Glaucoma

Subjects: Ophthalmology
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Glaucoma is defined as a progressive loss of the innermost nerve cells of the retina, the retinal ganglion cells, with a simultaneous characteristic loss of the peripheral visual field. The underlying cause for glaucoma remains unclear and the condition has been recognized as multifactorial with a potential important systemic involvement.

Keywords: glaucoma ; eye disease ; neurodegeneration ; blindness ; NTG ; HTG ; OHT

## 1. Introduction

Glaucoma is one of the most frequent causes of irreversible blindness worldwide [1], and the number of glaucoma patients will double by 2040 as a result of the growing elderly population [2]. A major risk factor for the development of glaucoma is elevated intraocular pressure (IOP), and the sole treatment strategies currently available are IOP-lowering medical or surgical treatments [3][4]. Although IOP-lowering treatment strategies often slow the rate of glaucoma progression, far too many go blind despite well-treated IOPs [3][4][5][6]. In this context, a Swedish study has shown that 42% of diagnosed glaucoma patients lose sight in one eye, while 15% end up blind [3].

## 2. Subgroups of Primary Open-Angle Glaucoma

The most common form of glaucoma in the western world is primary open-angle glaucoma (POAG). POAG can be subdivided into two clinical phenotypes depending on the IOP. Up to 50% of POAG patients have glaucomatous neurodegeneration despite an IOP within the normal range, denoted normal-tension glaucoma (NTG), while the rest have increased IOP, denoted high-tension glaucoma (HTG) [7][8]. In addition to these clinical subgroups within POAG, there is a group of patients with elevated IOP, but no signs of glaucomatous neurodegeneration, patients with ocular hypertension (OHT). The apparent resistance towards increased IOP in OHT patients formed the basis of the present study.

## 3. A Multifactorial Condition

It is recognized that glaucoma is a multifactorial condition with a number of competing risk factors [1][9]. The susceptibility towards the different risk factors is most probably different between patients. Thus, IOP may be a major risk factor in some patients, whereas other risk factors may be more significant in other patients. A widely suggested IOP-independent risk factor is dysfunctional retinal autoregulation [10][11]. Such dysfunctional retinal autoregulation will cause a fluctuating oxygen supply to the retina, thereby increasing the level of reactive oxygen species (ROS) [12][13]. In accordance with this, elevated levels of oxidative stress have been observed in POAG patients [9][14][15][16][17][18].

## 4. Methods

Since the retina has a very high oxygen-demand, decreased autoregulation and a fluctuating oxygen supply to the retina have been linked to glaucomatous neurodegeneration. To assess the significance of these mechanisms, we have utilized a human experimental model, in which we stress participants with a fluctuating oxygen supply. Levels of oxidative stress molecules, antioxidants, and lipid mediators were measured in the plasma.

## 5. Results

Patients with NTG, OHT, and control subjects were found to have similar levels of oxidative stress markers. In contrast, patients with OHT had a higher level of total antioxidant capacity (TAC) and pro-homeostatic lipid mediators. Thus, we suggest that OHT patients manage fluctuating oxygen levels more efficiently and, thus, are less susceptible to glaucomatous neurodegenerations, due to enhanced systemic antioxidant protection.

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