

## THE ROLE OF ARTERIAL HYPERTENSION IN THE DEVELOPMENT OF GLAUCOMA

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### **Abstract**

Arterial hypertension is one of the most prevalent chronic diseases worldwide and represents a major risk factor for cardiovascular, cerebrovascular, and ocular disorders. Glaucoma is a progressive optic neuropathy characterized by degeneration of retinal ganglion cells and irreversible visual field loss. Although elevated intraocular pressure is the most important risk factor for glaucoma, vascular factors play a significant role in the pathogenesis of the disease. Arterial hypertension affects ocular blood circulation, autoregulation, and perfusion pressure, which may contribute to the development and progression of glaucomatous optic neuropathy. The purpose of this article is to analyze the role of arterial hypertension in the development of glaucoma and to review the underlying pathophysiological mechanisms and clinical evidence.

### **Introduction**

Glaucoma is one of the leading causes of irreversible blindness worldwide. According to the World Health Organization, millions of people suffer from glaucoma, and the number is expected to increase due to aging of the population. The disease is characterized by progressive optic nerve damage, loss of retinal ganglion cells, and visual field defects.

Elevated intraocular pressure (IOP) is the main risk factor for glaucoma, but it is not the only one. Many patients develop glaucomatous optic neuropathy despite having normal intraocular pressure. This has led researchers to investigate the role of vascular and systemic factors in the pathogenesis of glaucoma.

Arterial hypertension is a chronic disease characterized by persistent elevation of systemic blood pressure. It affects the vascular system throughout the body, including the small vessels supplying the optic nerve and retina. Long-term hypertension causes structural and functional changes in blood vessels, which may impair ocular blood flow and contribute to optic nerve damage.

The relationship between arterial hypertension and glaucoma remains controversial. Some studies show that hypertension increases the risk of glaucoma, while others suggest that both high blood pressure and excessive lowering of blood pressure may contribute to disease progression.

### **Epidemiology**

Arterial hypertension affects more than one billion people worldwide and is one of the most common chronic conditions in adults. The prevalence increases with age and is often associated with diabetes mellitus, obesity, and atherosclerosis. Glaucoma is also strongly age-related. Primary open-angle glaucoma is the most common form and accounts for the majority of cases. Epidemiological studies suggest that patients with hypertension have a higher risk of developing glaucoma compared to normotensive individuals.

Several population-based studies have demonstrated that long-standing hypertension is associated with increased prevalence of optic nerve damage. However, the relationship is complex because antihypertensive therapy may also influence ocular perfusion pressure.

### **Pathophysiology of Arterial Hypertension**

Arterial hypertension causes structural and functional changes in the vascular system. Chronic elevation of blood pressure leads to thickening of the arterial wall, narrowing of the lumen, and reduced elasticity of blood vessels.

Endothelial dysfunction is one of the key mechanisms in hypertension. The endothelium plays an important role in regulating vascular tone and blood flow. In hypertensive patients, impaired nitric oxide production leads to vasoconstriction and reduced tissue perfusion.

Hypertension also promotes atherosclerosis, which further reduces blood supply to tissues. In the eye, these changes may affect the retinal and optic nerve circulation.

### **Pathophysiology of Glaucoma**

Glaucoma is characterized by progressive damage to the optic nerve head. The main mechanisms involved include mechanical stress due to elevated intraocular pressure and vascular insufficiency.

Increased intraocular pressure leads to compression of optic nerve fibers and impaired axoplasmic transport. At the same time, reduced blood flow to the optic nerve may cause ischemia and apoptosis of retinal ganglion cells.

Vascular dysregulation is considered an important factor in normal-tension glaucoma, where optic nerve damage occurs despite normal intraocular pressure.

### **Mechanisms Linking Arterial Hypertension and Glaucoma**

#### **1. Impaired Ocular Blood Flow**

Chronic hypertension causes narrowing of small arteries and arterioles, reducing blood flow to the optic nerve head. Decreased perfusion leads to ischemia and gradual loss of nerve fibers.

#### **2. Disturbance of Autoregulation**

Normally, ocular blood vessels maintain constant blood flow despite changes in systemic blood pressure. In hypertensive patients, autoregulation may be impaired, leading to unstable perfusion of the optic nerve.

#### **3. Changes in Ocular Perfusion Pressure**

Ocular perfusion pressure depends on systemic blood pressure and intraocular pressure. Both very high and very low blood pressure can reduce effective perfusion of the optic nerve.

Excessive lowering of blood pressure during antihypertensive therapy, especially at night, may lead to optic nerve ischemia.

#### **4. Endothelial Dysfunction**

Hypertension damages the vascular endothelium, leading to reduced production of vasodilators. This results in vasospasm and decreased blood supply to the optic nerve.

#### 5. Increased Intraocular Pressure

Some studies suggest that hypertension may increase intraocular pressure by increasing ultrafiltration in the ciliary body or by affecting aqueous humor outflow.

#### Clinical Studies

Many clinical studies have investigated the relationship between arterial hypertension and glaucoma.

Some studies show that hypertension is associated with higher intraocular pressure and increased risk of primary open-angle glaucoma.

Other studies suggest that long-term hypertension leads to vascular damage that increases susceptibility of the optic nerve to pressure-related injury.

There is also evidence that patients receiving aggressive antihypertensive therapy may develop worsening of glaucoma due to reduced ocular perfusion pressure.

#### Role of Antihypertensive Therapy

Antihypertensive drugs are necessary for preventing cardiovascular complications, but they may influence ocular circulation.

Excessive reduction of blood pressure, especially during nighttime, can reduce blood flow to the optic nerve. This phenomenon is known as nocturnal hypotension and is considered a risk factor for glaucoma progression. Therefore, careful monitoring of blood pressure patterns is recommended in patients with glaucoma.

#### Clinical Implications

Patients with arterial hypertension should undergo regular ophthalmologic examination. Early detection of optic nerve changes may prevent irreversible vision loss.

Doctors should consider both systemic blood pressure and intraocular pressure when managing patients with glaucoma.

Cooperation between cardiologists, therapists, and ophthalmologists is essential for optimal treatment.

#### Conclusion

Arterial hypertension plays a significant role in the development and progression of glaucoma through vascular damage, impaired autoregulation, endothelial dysfunction, and changes in ocular perfusion pressure. Both uncontrolled hypertension and excessive lowering of blood pressure may negatively affect optic nerve circulation. Early diagnosis, proper blood pressure control, and regular ophthalmologic monitoring are necessary to prevent glaucomatous optic neuropathy.

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