# ANALYZING NEOVASCULAR GLAUCOMA AND ANGLE-CLOSURE GLAUCOMA

**Wilda Najmi Hentihu**, Nanda Lessi Hafni Eka Putri  
*Faculty of Medicine, Universitas Tarumanagara, West Jakarta, DKI Jakarta, Indonesia*  
*najmihentihu@gmail.com*

## ARTICLE INFO

| Published: March 25th, 2023 |

**Keywords:** neovascular glaucoma, angle-closure glaucoma, glaucoma

---

**ABSTRACT**  
Neovascular glaucoma (NVG) is a secondary glaucoma that is generally associated with a poor visual prognosis. The development of new blood vessels above the iris and iridocorneal angle can block the outflow of aqueous humor and cause an increase in intraocular pressure. This study intends to analyze neovascular glaucoma and angle-closure glaucoma. This research is a case study conducted in a regional hospital in West Java. Researchers make direct observations in the field and collect data from observations and documentation. Researchers found that if acute angle-closure glaucoma is not detected and treated in its early stages, it can lead to temporary vision loss or blindness. There is loss of peripheral vision, followed by loss of central vision. There can be a significant increase in IOP in patients with peripheral patent iridotomy and flat front chambers of the eye. This condition is called malignant glaucoma. This condition is difficult to treat and progressively leads to blindness.

---

**INTRODUCTION**  
Neovascular glaucoma (NVG) is a secondary glaucoma that is generally associated with a poor visual prognosis (Kalogeropoulos et al., 2022; Rodrigues et al., 2016; Saikumar et al., 2018). The development of new blood vessels above the iris and iridocorneal angle can block the outflow of aqueous humor and cause an increase in intraocular pressure (Barac et al., 2015; Dumbrăveanu et al., 2022). The disease begins with retinal ischemia which is a complication of other diseases, especially diabetic retinopathy or retinal central vein occlusion. The condition of ischemia will trigger neovascularization and the formation of fibrovascular membranes in the anterior segment of the eye, especially the iris and iridocorneal angle, which will eventually obstruct the flow of aqueous humor of the eye (Rodrigues et al., 2016).

Data from the European Union estimates that 75,000-113,000 people are affected by NVG in Europe (Havens & Gulati, 2016). NVG makes up about 3.9% of all glaucoma (Khanna & Chang, 2022; Rani et al., 2021). In the USA, the overall prevalence of NVG is low but still contributes to significant vision loss and morbidity (Havens & Gulati, 2016). It is more common among elderly patients.

In Asia, it accounts for 0.7–5.1% of all glaucoma cases. In Saudi Arabia, the incidence reached 13% of the population in 2008 (Sivaprasad et al., 2012; Uy et al., 2021; Zheng et al., 2013). The incidence of neovascular glaucoma is associated with other diseases, namely in 65% of diabetic retinopathy patients and 60% of central retinal vein occlusion patients (Dumbrăveanu et al., 2022). Based on retrospective research from 2002 to 2012 in Saudi Arabia, the most associated risk factor was diabetes mellitus in 88% of patients, mostly with HbA1c levels of >7% (Al-Bahlal et al., 2017).
Neovascular glaucoma begins with a condition of impaired blood flow of the eye posterior segment (retina) which triggers hypoxia and retinal ischemia (Călugăru & Călugăru, 2022). Impaired blood flow is often associated with other diseases, the most common of which are diabetic retinopathy and occlusion of the central vein of the retina. The condition of ischemia will trigger vascular endothelial cells to inhibit blood vessel formation prevention factors (anti-angiogenic) in the form of pigment-epithelium derived factor and stimulate blood vessel forming supporting factors (pro-angiogenic) in the form of vascular endothelial growth factor (VEGF) and insulin growth-1 factor (Gacche & Meshram, 2014). This will mediate the activation, proliferation, and migration of endothelial cells for neovascularization, one of which in the anterior segment of the eye will form a fibrovascular membrane in the iris and iridocorneal angle (Wang & Johnson, 2022).

The neovascularization process occurs in inappropriate places and the quality is different, namely the permeability of blood vessel walls is higher due to the absence of tight intercellular junctions, so they are more susceptible to leakage and cellular inflammation (Sato et al., 2022). This process is usually accompanied by the formation of a fibrovascular membrane, which can block the flow of aqueous humor in the trabecular webbing. On the other hand, contraction of this membrane can form peripheral anterior synecia (goniosinekia) and progressive narrowing of the corner of the eye, resulting in an increase in intraocular pressure (IOP).

A thorough examination of the iris, anterior segment, and iridocorneal angle is important before dilating the pupil to examine the fundus area. Ophthalmological examination using a slit lamp. In the early stages, blood vessel growth will appear at the pupillary boundary and dam of the iris major circulus artery. Other findings were minimal reaction of the anterior segment, corneal edema due to increased IOP, and ciliary injection. Further examination with gonioscopy will reveal blood vessels from the edge of the pupil that migrate towards the iridocorneal angle with fine branching and cross the scleral spur towards the trabecular webbing, this process will create the condition of open-angle secondary glaucoma.

Supporting examinations to confirm the diagnosis, including electroretinography, iris fluorescent angiography, anterior segment optical coherence tomography (OCT), and ultrasound biomicroscopy. Electroretinography can distinguish cases of ischemia and non-ischemia in central retinal vein occlusion. Fluorescent angiography of the iris works in borderline cases to see leakage of iris blood vessels.

Based on the explanation, the researchers would like to conduct a study analyzing neovascular glaucoma and angle-closure glaucoma in a West Javanese general hospital. The research is expected to contribute to the knowledge of neovascular glaucoma and glaucoma in general.

**METHOD**

This research is a case study conducted in one of the hospitals in West Java. Researchers collected data from observations made at a hospital in West Java and then supplemented with data from documentation.
Management is carried out through two steps, namely:

1) Treatment of underlying disease, is an effort to suppress the ischemic drive to produce good long-term outcomes. Photocoagulation or commonly known as panretinal photocoagulation (PRP) is the main choice in an effort to reduce the stimulus of the neovascularization process accompanied by retinal ischemia.

This will decrease IOP in the secondary open-angle glaucoma stage and also increase the success of other surgical attempts to control IOP, such as the installation of an aqueous humor drainage device. PRP is usually performed in 1-3 sessions, using local anesthesia (topical/subconjunctival). The mechanism of action is unknown, but PRP is able to destroy the retinal photoreceptor pigment epithelium complex that plays a major role in retinal oxygen consumption. Oxygen will enter the choroid circulation and diffuse to the inside of the retina, thereby reducing hypoxic conditions and reducing angiogenic factor stimulation.

Intravitreal injection of anti-VEGF agents, such as bevacizumab, can trigger regression of the process of neovascularization of the iris and angle iridocornea in 24-48 hours, faster than PRP which requires 2-3 weeks. Several studies have also shown the role of antiVEGF in reducing inflammation and eye pain, better prognosis of vision quality outcomes, as well as decreased IOP. AntiVEGF is used as a co-treatment for the management of other neovascular glaucoma. Although the effect can be faster than PRP, the anti-VEGF suppression process is often temporary (4-6 weeks) and can undergo recurrence.

Therefore, intravitreal combination anti-VEGF injection with PRP is recommended for a permanent ischemic-angiogenic stimulation reduction effect. If this method is given at an early stage, neovascular glaucoma may be prevented.

2) Efforts to reduce IOP by medicamentose or surgery, depending on the stage when detected. The increase in IOP is due to trabecular webbing dysfunction and obstruction, so drugs that suppress the production of aqueous humor, including beta blockers, α-2 agonists, and carbonic anhydrase inhibitors, are the first choice with higher efficacy.

Prostaglandin analogue drugs that work to increase the flow of uveosclera, do not have a significant effect if the iridocorneal angle is already covered by a transparent fibrovascular membrane formed in the course of this disease. In addition, the administration of prostaglandin analogues risks increasing the incidence of inflammation related to blood-aqueous humour barrier disorders. Pilocarpine and other anticholinergic agents are contraindicated because they can increase inflammation, worsen goniosinekia and ciliary spasm, as well as decrease uveosclera flow from aqueous humor.

IOP control is essential for maintaining the condition of the optic nerve. Neovascular glaucoma is more difficult to control, especially if it is in the third stage when the condition of angular neovascularization of the iridocornea creates angle-closure glaucoma, so that nonsurgical treatment is no longer adequate. Surgical intervention can provide long-term IOP control as well as an opportunity for PRP to have an effect if done
Analyzing Neovascular Glaucoma and Angle-Closure Glaucoma

early. Some options include trabeculectomy with anti-metabolic agents, installation of an aqueous humor drainage device inside the eye, and cyclodestructive procedures. Risks of intraoperative and postoperative complications include hyphema, hypotony, cataracts, corneal decompensation, and surgical failure.

RESULT AND DISCUSSION

Epidemiology
Primary angle-closure glaucoma (PACG) is higher in Asia than Europe and Africa, with more than 80% of PAPGs worldwide in Asia. PACG affects about 0.75% of Asian adults, doubling per decade, and 60% of cases are women. Prevalence rates vary widely by ethnic region.

There are several risk factors for acute angle-closure glaucoma, including age, sex, race, and family history.
1) Age: The average age at presentation was 60, and prevalence increased thereafter. This is felt as the size of the lens increases with age;
2) Gender: There is a 4 to 1 ratio of incidence of angle-closure glaucoma in women versus men;
3) Race: Angle-closure glaucoma is more common in Southeast Asians, Chinese, and Eskimos. It is rare in black populations. In whites, acute angle-closure glaucoma accounts for 6% of all glaucoma diagnoses; and
4) Family history: Ocular anatomical features are inherited.

Etiology
The blockage of the flow of aqueous humor occurs due to a number of anatomical variations of the predisposition. These variations include a shallower anterior chamber, lens size, the anterior location of the iris-lens diaphragm, and a narrow entrance to the anterior chamber corner.

The shallower angle of the front eyechamber causes most of the iris and lens to come into contact with each other, slowing the flow of aqueous humor from the posterior chamber to the front eyechamber. This, in turn, causes pressure differences between chambers called pupil blocks. The pupil block causes the iris to curve, which narrows the angle of the anterior chamber even further. This cycle will perpetuate the increase in intraocular pressure leading to the clinical presentation of acute angle-closure glaucoma.

Pathogenesis
PACG occurs in eyes that have an anatomic predisposition to crowding of the corners of the front eye chambers, namely shallow eye chambers, thin ciliary bodies, thin irises, thick lenses located more anterior and shorter eyeball lengths. The pathophysiology of PACG involves two mechanisms of angle closure/obstruction of trabeculum webbing by the peripheral iris, namely pupil block and less often forms of the plateau iris (location of the iris insertion too anterior), swelling of the muda (in cataracts) and ciliary block (lens pushed forward on, penetrinal photocoagulation, scleral buckle insertion, etc.).
Acute PACG is caused by a sudden total closure of the angle, causing the circulation of the aqueous humor to stop completely and consequently an increase in IOP. The normal response of the eye to an environmental or chemical stimulus in the narrow-angle eye causes pathological iris-lens apposition. Apposition and contact of the iris – this lens is referred to as the pupil block. In the pupil block, the lens surface is located more anteriorly than the insertion of the iris into the ciliary body. As a result, there is an obstruction of the aqueous flow behind the iris causing the peripheral part of the iris to be pushed forward (iris bombe). Iris bombe will further close already narrow corners and interfere with aqueous drainage, increasing IOP.

![Diagram of open and closed angles](image)

**Figure 1.** Pupil Block

**Clinical manifestations**

Acute attacks often occur at night. Patients are usually old, without a history of glaucoma, with complaints of severe pain around the eyes, red, and suddenly blurred vision. Another complaint is a halo around the object. Pain feels like boring accompanied by ipsilateral headache, and in severe cases can be accompanied by nausea / vomiting, IOP increases sharply and in acute cases can reach 45 mmHg. The eyes appear hyperemic, and the pupils look mid-dilated (4-6mm), unresponsive to light. Corneal opacities occur due to edema and the front chambers of the eye appear shallow with penlight examination. In calmer conditions, fundal examination is needed to determine the picture of the optic papilla.

It is important to note the variety of symptoms of acute angle-closure attacks. Blacks with acute attacks can feel only slight pain with no signs of damming even though IOP is very high, symptoms are limited to visual impairment. In many patients, extraocular symptoms and systemic manifestations can be the main complaints (headache, vomiting, abdominal pain)
Analyzing Neovascular Glaucoma and Angle-Closure Glaucoma

Figure 2. Dangal Front Eye Room

Diagnosis
Acute PACG is if it meets 2 of the following symptoms: ocular pain, nausea/vomiting, blurry vision with halo; and at least 3 of the following signs: IOP greater than 21 mmHg, conjunctival injection, corneal epithelial edema, nonreactive and mid-dilated pupils, shallow front chamber of the eye. Genoscopic examination is needed to evaluate the structures of the front chambers of the eye; In acute conditions can be seen attachment of the base of the iris with the cornea (complete iridocorneal contact).

Diagnosis Banding
1) Angle-closure glaucoma secondary to intumescent cataract (swollen or dislocated lens)
2) Glaucoma fakolitik
3) Neovascular glaucoma, sometimes can cause sudden pain and bedburn
4) Other causes of headaches around the eyes such as migraine headaches and migraine neuralgia (cluster headache)

Management
The principle of management in acute attacks is to reduce IOP, suppress inflammation, and open closed corners. As soon as the diagnosis of acute PACG is made, the first step is with a medicamentose consisting of acetazolamide, topical beta-blocker, and topical steroids.

Medical treatment is with the administration of the following drugs:
1) Carbonic anhydrase inhibitor: At the beginning of therapy given acetazolamide tablets 500mg, followed by acerazolamidoral 4x 250mg after 1 hour, until intraocular pressure becomes normal (<21 mmHg);
2) Metabeta drops – 0.5% blockers: Beta-blocker eye drops are given 2x daily to help lower IOP;
3) Steroid drops: Administered when the patient has severe pain and headache;
4) 2% pilocarpine drops: Pilocarpine (myoticum) is only started 1/2 to 1 hour after initial medical therapy because the pilocarpine area can only work after iris ischemia has decreased and IOP <40 mmHg. Pilocarpine 2% is given 2x intervals of 15 minutes, then
Analyzing Neovascular Glaucoma and Angle-Closure Glaucoma

given 6x1 drops to the affected eye. Eyes that do not experience attacks are also given pylocarpine 15 prophylaxis 4x a day, until laser iridotomy; and

5) Hyperosmotic drugs: Used if IOP is very high (>50mmHg) and if acetazolamide has no effect. Hyperosmotic drugs can be found as glycerin or mannitol. The oral dose of 50% glycerin solution is 1-1.5 gr/kgBB in lime juice: the intravenous dose of 20% mannitol is 2gr/kgBB. Hyperosmotic drugs can only be given in health facilities that have adequate monitoring for the patient's sitemic condition. Because of the side effects of hyperosmotic administration that can be life-threatening, such as edem cerebri, pulmonary edem, heart failure, and others.

The operative treatment is peripheral iridotomy with the Nd:YAG laser, which aims to re-establish the connection between the front chamber of the eye and the back eye chamber by creating a "door" in the peripheral iris. This action will be successful only if the angle covered by permanent peripheral anterior synecia is only <50%. If it is more than 50%, trabeculectomy is indicated. Iridotomy with argon laser can be performed.

CONCLUSION

The prognosis depends on early detection and prompt treatment of acute angle-closure glaucoma. A study conducted on 116 cases of acute angle-closure glaucoma concluded that delays in presentation and the time it takes to end an acute episode are the most important factors in determining the final outcome of these patients. High intraocular pressure is less effective in determining the long-term prognosis of this condition.

If acute angle-closure glaucoma is not detected and treated in its early stages, it can lead to temporary vision loss or blindness. There is loss of peripheral vision, followed by loss of central vision. There can be a significant increase in IOP in patients with peripheral patent iridotomy and flat front chambers of the eye. This condition is called malignant glaucoma. This condition is difficult to treat and progressively leads to blindness.

The researchers realize that there are gaps left here. Therefore, future research are expected to conduct more in-depth studies regarding glaucoma, especially neovascular and angle-closure ones. With more insight, hopefully, faster glaucoma recovery can be achieved.

REFERENCE


Analyzing Neovascular Glaucoma and Angle-Closure Glaucoma


2687 | Indonesian Journal of Multidisciplinary Science, 2(6), March, 2023