RESEARCH PAPER

To Study Short-Term Effect of Standard Automated Perimetry Testing On Intraocular Pressure in Patient With Glaucoma

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Received: 17th Mar, 2026 | Revised: 29th Mar, 2026 | Accepted: 19th Apr, 2026 | Available Online: 5th May, 2026

ABSTRACT

Background: Visual field testing is often performed on glaucoma patients just before the ophthalmological consultation because VF analysis is essential for identifying glaucoma development and avoiding abnormal VF results associated with an earlier eye examination.

Objectives: The present study was conducted to find changes in IOP measurement after Humphrey perimetry in patients with glaucoma & To study relation of IOP with different strategy of Humphrey perimetry. Seventy patients with glaucomatous changes were included and analysed in the present study.

Materials and Methods: The cross-sectional study was conducted among 70 patients with high intraocular pressure. They all were undergone complete ophthalmic evaluation along with detailed Ocular and medical history followed by examination and measurements. Visual field-testing Humphrey Perimetry with various protocols. IOP was measured by Goldmann applanation tonometer before and after visual field testing.

Results: Before perimetry, the mean intraocular pressure in the right eye among study participants was 20.20 mmHg (SD 4.98 mmHg); in the left, it was 19.67 mmHg (SD 3.67 mmHg). The mean intraocular pressure in the right eye among study participants after 2 minutes of perimetry was 21.15 mmHg (SD 4.47 mmHg); in the left, it was 20.67 mmHg (SD 3.59 mmHg). In the present study, IOP was significantly higher among study participants after perimetry in both eyes. Humphrey perimetry with full threshold was used among 21.4% of the patients. SITA standard 24-2 and SITA fast 24-2 was used among 52.9% and 7.1% of the study participants, respectively. SITA standard 10-2 and Full threshold 10-2 was employed among 12.9% and 5.7% of the patients, respectively.

Conclusion: In present study, intraocular pressure after Humphrey perimetry is significantly increased among glaucoma patients. Compared to the SITA Standard 24-2,10-2 and SITA fast, the Full Threshold 30-2 & 10-2 takes more time to complete, increasing the likelihood of an increase in intraocular pressure.

Keywords: Visual Field Testing, Intraocular Pressure, Perimetry, Glaucoma

How to cite this article: Pathakjee R V, Patel D, Maniar K, Shah P, Shah J., To Study Short-Term Effect of Standard Automated Perimetry Testing On Intraocular Pressure in Patient With Glaucoma. Int J Drug Deliv Technol. 2026;16(43s): 1402-1412; Doi: 10.25258/Ijddt.16.43s.148

INTRODUCTION

Glaucoma is a chronic group of progressive optic neuropathies characterised by a degradation of retinal ganglion cells and retinal nerve fibre layers that result in abnormalities in the optical nerve head which lead to degeneration of optic nerve with loss of visual fieldand cause of permanent blindness. [1,2]

Primary and secondary glaucoma are the two most common forms of the eye disease glaucoma.

According to the underlying anatomy and pathophysiology, these two conditions each have two primary subgroups, which are referred to as open-angle and angle-closure.[1,5]

Glaucoma may be diagnosed if the affected eye has an increased vertical cup disc ratio(≥0.6) and an abnormal visual field defect that corresponds to the optic disc and is linked with higher or normal intraocular pressure.8Tonometry is an important aspect of both the diagnosis and follow-up of glaucoma. It is important to do a single measurement of the central corneal thickness as well as the corneal curvature in order to ensure that tonometric values are accurate.[9,10]

The second method used in the diagnosis and subsequent monitoring of glaucomatous optic-nerve damage is called the perimetric visual-field assessment. The diagnostic accuracy of this method improves along with the progression of glaucoma.[5,11]

Humphrey perimetry, Octopus perimetry, and Oculus perimetry are types of static perimetry. The Humphrey visual field test assesses the extent of peripheral vision while the eye is focused on a central point. During this test, lights of increasing brightness emerge in various areas of the patient's visual field while his or her eye is fixated on a specific point.[14]

However, intraocular pressure (IOP) is a highly variable and dynamic parameter that is affected by a wide variety of factors, including measurement factors (such as tonometer and examiner), ocular factors (such as corneal thickness, corneal hysteresis, and dehydration), and individual factors (such as age and gender) (such as accommodation, circadian cycle, body position, mental stress, and blood pressure). Because of this, it is of the utmost importance for ophthalmologists to be aware about changes in intraocular pressure (IOP) and the impact that these variations have on the clinical treatment and follow-up of glaucoma patients. [16,17]

In most cases, IOP is evaluated both before to and after to SAP testing. There is a risk that a visual field examination carried out before an IOP measurement and using both topical anaesthetics and fluorescein dye may alter the IOP results, leading the physician to incorrectly believe that the patient's glaucoma treatment plan should be intensified.[19]

AIMS AND OBJECTIVE

- To Study changes of IOP measurement after Humphrey perimetry in patient with glaucoma.
- To study association between IOP and Humphrey perimetry.
- To study relation of IOP with different strategy of Humphrey perimetry.

REVIEW OF LITERATURE

Lee CM et al. conducted a study to assess the short-term effects of standard automated perimetry (SAP) testing on intraocular pressure (IOP) in patients with open-angle glaucoma (OAG) who were under stable medical treatment. They evaluated 71 eyes from 45 individuals, measuring IOP with an iCare rebound tonometer at four intervals: immediately before, immediately after, 10 minutes after, and 20 minutes after SAP testing. The average baseline IOP was 13.29 mmHg with a standard deviation of 3.06 mmHg. They found that the change in IOP 10 minutes after the SAP test was statistically significant, but not the changes measured immediately after or 20 minutes later. However, these differences were within the measurement error range of the tonometer and thus not clinically meaningful. Logistic regression revealed no significant relationship between IOP changes and variables such as test duration, mean deviation, medication type, or age. The authors concluded that SAP testing does not result in a substantial change in IOP in OAG patients and that post-SAP IOP measurements using rebound tonometry are generally reliable.

Nina N et al. explored whether visual field (VF) testing has a short-term influence on IOP during the same clinical visit in primary open-angle glaucoma patients. They included 109 right eyes from patients with stable disease, with no recent changes in glaucoma treatment. IOP measured 30 minutes after VF testing was compared to IOP at prior and subsequent visits where no VF testing had been performed. The study found that the average IOP after VF testing was higher than at both comparison visits, and 22.9% of patients experienced an IOP increase greater than 20%. Subgroup analyses showed that eyes with surgical pressure control had a smaller IOP rise than those managed medically, and patients using β-blockers or α2-agonists experienced a lesser IOP

increase than those on prostaglandins or carbonic anhydrase inhibitors. These results suggest that VF testing may induce a temporary elevation in IOP in some POAG patients, particularly in those managed with topical medications.

Bertaud S et al. performed a prospective observational study to evaluate whether VF testing impacts IOP in patients with ocular hypertension (OHT) or glaucoma. They studied 150 right eyes from 95 patients, measuring IOP three times using a non-contact tonometer (Nidek NT-510) both before and after VF testing. The IOP measurements were taken within five minutes of each other to ensure consistency. The average change in IOP was minimal at 0.15 mmHg, with a standard deviation of 1.82 mmHg, and multivariate analysis found no significant relationship between IOP variation and factors like age, gender, central corneal thickness, VF test duration, or surgical history. The researchers concluded that automated VF testing does not significantly affect IOP when assessed using non-contact tonometry, and any minor fluctuations observed were not clinically meaningful.

Li M et al. investigated how VF testing influences IOP in both healthy individuals and patients with controlled OAG. The study included 80 eyes from 40 healthy volunteers and 62 eyes from 31 glaucoma patients. IOP was measured in both eyes using a non-contact tonometer at five time points: before, immediately after (0 minutes), and at 10, 30, and 60 minutes following standard VF testing. In healthy eyes, IOP gradually decreased after VF testing, showing reductions of 1.5% immediately after, 6.5% at 10 minutes, 6.6% at 30 minutes, and 7.0% at 60 minutes. In contrast, glaucomatous eyes experienced an immediate IOP increase of 12.7% right after VF testing, followed by a gradual return to baseline by 60 minutes. Repeated measures ANOVA confirmed that the IOP change patterns differed significantly between healthy and glaucomatous eyes. The authors concluded that VF testing induces different IOP responses depending on ocular health status: a mild, sustained IOP reduction in healthy individuals and a transient IOP elevation in glaucoma patients. Therefore, clinicians should consider the timing of IOP measurement in relation to VF testing, especially in glaucoma management.

MATERIAL AND METHOD

Study setting:

- The study was conducted in the outdoor patient department of Ophthalmology department at Dhiraj hospital, Piparia, Waghodia, Vadodara, Gujarat.

Study type:

- It was a cross sectional (observational) study.

Study duration:

- The study was conducted for one and half year of duration.

Study participants:

Inclusion criteria:

⇒ Patients of more than 18 year of age.

⇒ Patients with glaucomatous optic disc changes

⇒ Patients with glaucomatous visual field changes

⇒ Patients with glaucoma suspect.

⇒ Patients with normal or high IOP

⇒ Willing to participate in study

Exclusion criteria:

⇒ Patient with any corneal pathology like keratoconjunctivitis, corneal ulcer.

⇒ Patients with previous ocular surgeries

⇒ Patients who had Difficulty in sitting on slit lamp examination [For IOP measurement]

⇒ Uncooperative patients for perimetry

⇒ Patients with any ocular infection like conjunctivitis.

⇒ Patients who were not willing to participate in study

Sample size:

Minimal sample size require for the present study was obtained by using the hypothesis testing method, and based on the following formula-

$$n = \frac{Z^2\, p\, (1-p)}{L^2}$$

Where-

Z = Z value at 95% confidence intervals = 1.96

p = the prevalence of Glaucoma = 2.2% (Wiggs JL et al.[63])

1-p = 97.8

L = Margin of error = 4%

The calculated minimum sample was 52 which had been inflated by 10% for anticipated subject non-response. Finally,70 Individuals were included in to the analysis.

Sampling technique:

- All eligible participants were acquired purposively in the present study.

Study tools:

⇒ Patient ID, age, gender and contact details.

History of the study participants

⇒ It included following Details regarding

⇒ Present history like redness/discharge, pain, photophobia

⇒ History of glaucoma and medications using for glaucoma,

⇒ History of using steroid medications

⇒ History of any trauma or ocular surgery and any pre-existing systemic illness.

⇒ Family history of glaucoma

⇒ History of diabetes mellitus

⇒ Duration of diabetes

⇒ Ongoing treatment for diabetes mellitus

⇒ Last ophthalmic check-up

Study Measurements:

Measurement of refractory errors:

⇒ All participants were tested through autorefractometer refractive readings for refractory errors.

Measurement of Visual acuity:

⇒ Visual acuity was measure through Snellen's chart which included uncorrected Visual Acuity (UCVA) and Best Corrected Visual Acuity (BCVA)

Measurement of Intraocular pressure

⇒ Intraocular pressure measurement by calibrated Goldmann applanation tonometer.

Gonioscopy

⇒ Gonioscopy was carried out by four mirror Zeiss goniolens to know the status of the angle of the anterior chamber.

Slit lamp bio microscopy:

⇒ It was done for the examination of anterior and posterior segment. It included examination of eyelashes, eyelids, lacrimal apparatus conjunctiva, cornea, iris, pupil, lens.

Fundus examination

⇒ Dilated Fundus examination was carried out with the help of Slit lamp biomicroscopy with 90 D &78 D Zeiss lens.

Pachymetry

⇒ It was determined by ultrasonic pachymetry (PACSCAN 300p). Three readings were taken and average of all those three readings were taken in to account.

Visual field testing:

⇒ It was done by Humphrey Perimetry with following protocols and respective duration

30-2 full threshold – 14 minutes

24-2 SITA standard - 7 minutes

24-2 SITA fast - 5 minutes

10-2 SITA standard -7 minutes

24-2 full threshold -12 minutes

SITA Standard or Full Threshold testing strategy is commonly used and if the patient is old and not able to concentrate for longer time SITA Fast was selected. All the measurements were done by single observer to reduce inter observer bias.

RESULT

Table 5-1: Age distribution of study participants

Age	**Mean**	**SD**
Mean age (years)	56.71	8.44
Age categories	**Number**	**Percentage**
41-50	15	21.4
51-60	32	45.7
61-70	20	28.6
>70	03	4.3

In present study the mean age of the study participants was 56.71 years (SD 8.44 years). Majority (45.7%) of the study participants were in the age group of 51-60 years while 28.6% were in the age group of 61-70 years. Participants aged 41 to 50 years were 21.4% while 4.3% were of more than 70 years.

Figure 5-1: Age distribution of study participants

Table 5-2: Gender distribution of study participants

Gender	Number	Percentages
Male	48	68.6
Female	22	31.4

As per Table 5-2, there were 68.6% males and 31.4% females in the present study

Table 5-3: Intraocular pressure before perimetry among study participants

IOP (mm Hg)	Mean	SD
Right eye	20.20	4.98
Left eye	19.67	3.67

Before perimetry, the mean intraocular pressure in right eye among study participants was 20.20 mmHg (SD 4.98 mmHg) and in the left eye it was 19.67 mmHg (SD 3.67 mmHg)

Table 5-4:Intraocular pressure after 2 minutes of perimetry among study participants

IOP (mm Hg)	Mean	SD
Right eye	21.15	4.47
Left eye	20.67	3.59

The mean intraocular pressure in right eye among study participants after 2 minutes of perimetry was 21.15 mmHg (SD 4.47 mmHg) and in the left eye it was 20.67 mmHg (SD 3.59 mmHg)

Table 5-5: Uncorrected Visual acuity in the right eye among the study participants

UCVA right eye	Number	Percentages
6/12	9	12.9
6/18	3	4.3
6/24	12	17.1
6/36	13	18.6
6/60	11	15.7
6/9	6	8.6
CF 2m	2	2.9
CF 4m	14	20.0

As pe Table 5.5, 18.6% had 6/36 uncorrected vision in right eye while 17.1% and 15.7% had 6/24 and 6/60 uncorrected vision in right eye respectively. 6/12 and 6/9 UCVA in right eye was seen among 12.9% and 8.6% respectively among study participants. Finger counting at 2 meters and 4 meters in right eye was seen in 2.9% and 20% respectively.

Table 5-6: Uncorrected Visual acuity in the left eye among study participants

UCVA left eye	Number	Percentage
6/12	12	17.1
6/18	3	4.3
6/24	16	22.9
6/36	8	11.4
6/60	12	17.1
6/9	6	8.6
CF 3m	13	18.6

In present study, 22.9% had 6/24 left eye uncorrected visual acuity. 6/12, 6/60 and 6/36 left sided UCVA was observed in 17.1%, 17.1% and 11.4% respectively among study participants. Finger counting at 3 meter distance in left eye was seen among 18.6% of the study participants.

Table 5-7: Best corrected visual acuity in right eye among study participants

BCVA right eye	Number	Percentage
6/12	22	31.4
6/18	8	11.4
6/24	2	2.9
6/36	11	15.7
6/6	6	8.6
6/9	21	30.0

After best correction 6/6 and 6/9 vision in the right eye was observed among 8.6% and 30% of the study participants. 6/12, 6/18 and 6/24 BCVA was

seen among 31.4%, 11.4% and 2.9% respectively among study participants.

Table 5-8: Best corrected visual acuity in left eye among study participants

BCVA left eye	Number	Percentage
6/12	19	27.1
6/18	5	7.1
6/24	6	8.6
6/36	9	12.9
6/6	6	8.6
6/9	25	35.7

After best correction, 6/6 and 6/9 vision was seen among 8.6% and 35.7% of the study participants in the left eye. 6/12, 6/18 and 6/24 BCVA was observed among 27.1%, 7.1% and 8.6% respectively among study participants.

Table 5-9: Humphrey Perimetry with different strategy (n=70)

TEST PATTERN	*STRATEGY*	*TIME*	*NO. OF PATIENT*	*PERCENTAGE(%)*
30-2	FULL THRESHOLD	15 min	15	21.4
24-2	SITA STANDARD	7 min	37	52.9
24-2	SITA FAST	5 min	5	7.1
10-2	SITA STANDARD	7 min	9	12.9
10-2	FULL THRESHOLD	12 min	4	5.7

In present study Humphreyperimetry of 30-2full threshold was used among 21.4% of the patients. SITA standard 24-2 was used among 52.9% andSITA fast 24-2was employed among 7.1% of the study participants. SITA standard 10-2 strategy used in 12.9% patient and Full threshold 10-2 was employed among 5.7% of the patients.

Table 5-10: Changes in IOP after Humphry perimetry

TEST PATTERN	*STRATEGY*	*TIME*	*NO. OF EYES (TOTAL - 140)*	*IOP decrease*	*IOP increase*	*IOP no change*
30-2	Full threshold	15 min	30	1	20	9
24-2	Sita standard	7 min	74	9	35	30
24-2	Sita fast	5 min	10	2	0	8
10-2	Sita standard	7 min	18	4	8	6
10-2	Full threshold	12 min	8	0	5	3

Compared to the SITA Standard 24-2,10-2 and SITA fast, the Full Threshold 30-2 & 10-2 takes more time to complete, increasing the likelihood of an increase in intraocular pressure.

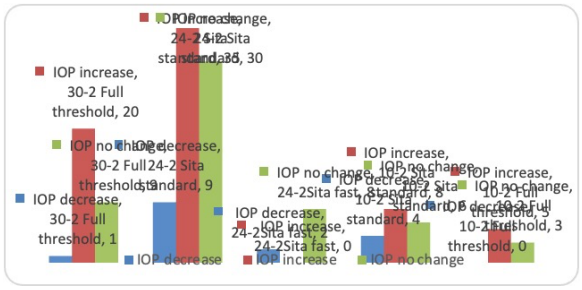

Figure 5-10: Changes in IOP after Humphry perimetry

Table 5-11: Comparison of IOP before and after perimetry

Side	Intraocular pressure		p-value
	Before perimetry	After perimetry	

Right eye	**20.20 ± 4.98**	**21.15 ± 4.47**	**<0.001**
Left eye	**19.67 ± 3.67**	**20.67 ± 3.59**	**<0.001**

In present study, intraocular pressure in right eye were significantly higher among study participants after perimetry (20.20 mmHg vs 21.67 mmHg). IOP in left eye was also significantly higher after perimetry (19.67 mmHg vs 20.67 mmHg)

DISCUSSION

Visual field testing is often performed on glaucoma patients just before the ophthalmological consultation because VF analysis is essential for identifying glaucoma development and avoiding abnormal VF results associated with an earlier eye examination. Because IOP is the only treatable parameter and has been proven to delay the progression of glaucoma, its measurement during the consultation directly impacts the choice of therapy. It has been noted, however, that VF testing may increase IOP in some people, which may be critical and need the VF test outside the consultation. It is well-accepted that environmental factors affect IOP.[7,68]

The present study was conducted to find changes in IOP measurement after Humphrey perimetry in patients with glaucoma. Seventy patients with glaucomatous changes were included and analysed in the present study.

The present study participants' mean age was 56.71± 8.44 years. In the study done by **Li M et al.,[21]** the mean age of glaucoma patients was 45.0± 14.6years; in the study done by **Gurung M et al.,[69]** the mean age of glaucoma patients was 52.2 ± 9.5 years, In this research, the majority (45.7%) of the study participants were in the age group of 51-60 years while 28.6% were in the age group of 61-70 years. Participants aged 41 to 50 were 21.4%, while 4.3% were more than 70.

Glaucoma is exacerbated by ageing. Ageing may increase the susceptibility of the optic nerve to IOP-related injury, eventually leading to ganglion cell loss in the retina (RGCs). This age-associated increased sensitivity to neuronal damage has also been reported in other neurodegenerative conditions, such as Alzheimer's disease and Parkinson's disease, and may be connected, among other variables, to mitochondrial malfunction and poor ability to manage oxidative stress.[70,71]

In our research, 68.6% of males and 31.4% of females were in the present study.In the study by **Li M et al.,[21]**67.74% were males, while 32.26% were females in the glaucoma group, which agrees with the present study. In the study by **Gurung A et al.,[69]** there were 57.4% of males and 42.6% of females.

In present study Humphrey perimetry with full threshold was used among 21.4% of the patients. SITA standard 24-2 and SITA fast 24-2 was used among 52.9% and 7.1% of the study participants, respectively. SITA standard 10-2 and Full threshold 10-2 was employed among 12.9% and 5.7% of the patients, respectively.

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In patients with glaucoma, 24-2 standard automated perimetry (SAP) has been considered as the most commonly applied perimetry to examine the visual function. The 24-2 and 30-2 tests are testing techniques in Matrix that investigate 55 and 69 locations, respectively, using 5^0 targets. The 10-2 (44 point) tests investigate the centre 10^0 with 2^0 sized targets that are counterphase-flickering at a slower pace (12 Hz). It is used for neuro-ophthalmic conditions and general screening as well as early detection of glaucoma.[72,73]

The visual field loss (scotoma) in glaucoma has a specific pattern that is different from other forms of vision loss. Bjerrum scotoma, paracentral scotoma, nasal step, and arcuate defect are the visual field defects. These deficiencies correlate to the loss of retinal nerve fibers, which often starts in the arcuate bundles and finishes in the papillomacular bundle. 30-2 perimetry taking more time compare to 10-2 So more chances of rise in intraocular pressure in 30-2 compare to 24 & 10.[7,59]

In the present study, intraocular pressure measurement by calibrated Goldmann applanation tonometer. Before perimetry, the mean intraocular pressure in the right eye among study participants was 20.20 mmHg (SD 4.98 mmHg); in the left, it was 19.67 mmHg (SD 3.67 mmHg). Glaucoma is a separate set of optic nerve neuropathies defined by particular abnormalities to the

optic disc and visual field, often accompanied by a rise in intraocular pressure (IOP). In the past, persons with a real IOP of up to 21 mmHg were deemed healthy. Some people nowadays regard an IOP between 18 and 22 to be borderline.[2,74] The phrase "true IOP" refers to the IOP that has been adjusted based on the thickness of the cornea and other factors that affect IOP. Increase of the cup (cupping) and reduction of the rim containing the axons from the retinal ganglion layer are the most significant changes to the optic disc. Disc notching, increased excavation, retinal nerve fiber abnormalities, and papillary flame-shape hemorrhages are early indicators of this condition. Bjerrum defects (scotoma), paracentral scotoma, nasal step, and arcuate scotoma are among the first alterations in the visual field

In present study, the mean intraocular pressure in the right eye among study participants after 2 minutes of perimetry was 21.15 mmHg (SD 4.47 mmHg); in the left, it was 20.67 mmHg (SD 3.59 mmHg). In the present study, intraocular pressure in the right eye was significantly higher among study participants after perimetry in both eyes. Previous research about the impact of VF testing on IOPhas yielded inconsistent and conflicting results. **Nina et al.[20]** reported a more than 20% increase in IOP after VF testing compared with IOPs from the previous and next visits without VF testing in 22.9% of POAG patients.

Recupero et al.[76] found that visual field testing led to a transient IOP increase of more than two mmHg in 44.7% of POAG patients but no IOPchange in healthy subjects.Using the Humphrey Visual Field Analyzer (HFA), he found that the intraocular pressure (IOP) of glaucoma patients varied before and after VF exams. The impact was especially pronounced in the elderly. Maximum IOP elevation was 11 mm Hg. Lack of accommodation was suggested as one of the potential causes of IOP rise after VF evaluation.

On the contrary, **Rebolledo et al.**[77]found that IOP did not vary significantly immediately after VF testing compared with 1hour later in 27 POAG patients. **Martin et al.**also found no significant differences in IOP values between immediately before and immediately after routine VFtesting in 40 treated glaucoma patients and 21 untreated ocular hypertension or suspected glaucoma. **Sawada et al.** concluded that VF testing did not lead to an increase in IOP in the majority of glaucoma eyes.

Some individuals may regard VF testing as stressful, resulting in a sympathetic reaction that temporarily rises intraocular pressure (IOP) as norepinephrine (NE) is released into the aqueous humor, resulting in a considerable increase in intraocular pressure (IOP).[78]**Erb et al.[79]** demonstrated that psychological stress can increase intraocular pressure, possibly as a result of a sympathetic response that raises blood pressure and heart rate.

CONCLUSION

In present study, intraocular pressure after Humphrey perimetry is significantly increased among glaucoma patients. Compared to the SITA Standard 24-2,10-2 and SITA fast, the Full Threshold 30-2 & 10-2 takes more time to complete,increasing the likelihood of an increase in intraocular pressure.Visual filed testing may result in a sympathetic reaction that temporarily rises intraocular pressure (IOP). IOP is substantially affected by sympathetic input. When sympathetic cervical nerves are directly activated, norepinephrine (NE) is released into the aqueous humor, resulting in a considerable increase in intraocular pressure (IOP).

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