Change in Intraocular Pressure Before and After Pharmacologic Mydriasis in Normal Controls and group of Glaucoma Patients

Abstract

Purpose:
To assess changes in intraocular pressure (IOP) following pharmacological pupil dilatation with 0.8% tropicamide and 5% phenylephrine in normal controls, primary angle-closure glaucoma (PACG) patients post-YAG peripheral iridotomy (PI), and subjects with primary open-angle glaucoma (POAG).

Methods:
This cross-sectional prospective study included 48 eyes—15 normal, 17 PACG post-YAG PI, and 16 POAG. IOP was measured with a Goldmann applanation tonometer before and 30 minutes after single instillation of mydriatic drops (0.8% tropicamide + 5% phenylephrine). Statistical analyses included Wilcoxon rank sum and Mann-Whitney U tests.

Results:
IOP increased post-dilatation in all groups. The mean change (±SD) was 1.73 ± 1.83 mmHg in controls, 2.35 ± 1.93 mmHg in PACG post-YAG PI, and 2.62 ± 1.89 mmHg in POAG. The increase was statistically significant within PACG and POAG groups ($p < 0.05$) but not significant when these groups were compared to normal controls ($p > 0.05$).

Conclusions:
Pharmacologic dilatation can cause a significant intra-group elevation of IOP in PACG (post-YAG PI) and POAG eyes, but the difference between glaucoma patients and normal controls was not significant in this study. Routine IOP monitoring before dilatation is recommended, and caution is advised in glaucoma patients undergoing mydriasis.

Keywords:
intraocular pressure, glaucoma, PACG, POAG, YAG-PI, mydriasis, tropicamide, phenylephrine

Introduction

Accurate assessment of intraocular pressure (IOP) is essential in the management of glaucoma. Pharmacologic mydriasis is commonly performed in clinical practice for diagnostic purposes; however, it is reported to affect IOP, particularly in glaucoma patients. This study evaluates the change in IOP following pupil dilation in normal controls and two major subtypes of glaucoma: POAG and PACG post-YAG PI.

Aqueous Humor: Composition, Functions, and Measurement Techniques

Aqueous humor is a transparent, watery fluid secreted by the non-pigmented epithelium of the ciliary body. It plays a vital role in maintaining ocular physiology and visual function. One of its primary functions is the regulation of intraocular pressure, which is essential for the structural integrity of the eye. Additionally, aqueous humor provides oxygen and essential nutrients such as amino acids and glucose to avascular ocular tissues, including the lens, trabecular meshwork, and the posterior part of the cornea. It also facilitates the transport of ascorbate to the anterior segment, where it acts as an antioxidant, protecting ocular tissues from oxidative stress. Beyond its nutritive and protective roles, aqueous humor contributes to immune responses within the eye, supports the refractive index

necessary for proper light transmission, and serves as a medium for the removal of metabolic and toxic waste products. Its transparency is crucial for unobstructed vision.

The normal rate of aqueous humor formation is approximately 2.6 to 2.8 µl per minute. To assess this rate in individuals, two broad categories of measurement techniques are employed: pressure-dependent methods and tracer-based methods. Pressure-dependent techniques include tonography, suction cup methods, and perfusion studies, which rely on changes in intraocular pressure to estimate production rates. Tracer methods, on the other hand, involve the use of substances such as fluorescein, fluoresceinated dextrans, iodide, radiolabeled isotopes, and photogrammetry to track the movement and turnover of aqueous humor within the eye. These diagnostic approaches are essential for understanding aqueous dynamics, particularly in the context of glaucoma and other ocular pathologies.

Aqueous Humor: Functions & Dynamics

Aqueous humor is a transparent fluid secreted by the non-pigmented epithelium of the ciliary body. It:

- Maintains intraocular pressure (IOP)
- Nourishes avascular tissues (lens, cornea, trabecular meshwork)
- Transports antioxidants (ascorbate)
- Supports immune response
- Contributes to refractive index
- Removes metabolic waste
- Provides a clear optical medium

Formation Rate: 2.6–2.8 µl/min
Measurement Methods:
Pressure-dependent: Tonography, suction cup, perfusion
Tracer-based: Fluorescein, iodide, radiolabeled isotopes, dextrans, photogrammetry

Aqueous Outflow Pathways
After forming in the posterior chamber, aqueous humor flows to the anterior chamber via the pupil.
Major Route (90%) – Trabecular Meshwork:
Uveal meshwork: Root of iris → Schwalbe's line
Corneoscleral meshwork: Scleral spur → Schwalbe's line
Juxtacanalicular meshwork: To Schlemm's canal → Collector channels → Episcleral veins

Minor Route (10%) – Uveoscleral Outflow

Resistance in outflow pathways prevents backflow and blood entry into the anterior chamber.

Vitreous Humor

Fills ~4/5th of the eyeball; transparent, gelatinous mass between lens and retina. Quantity stabilizes after age 5–6.

Intraocular Pressure (IOP)

IOP is the fluid pressure exerted on the eyeball wall, determined by aqueous production vs. outflow.

OutflowEquation: $R=C(P_o-P_e)$

R = Outflow rate (normal: 2 µl/min)

C = Outflow facility (0.2 µl/min/mmHg)
P_o = IOP (normal: 7–21 mmHg)
P_e = Episcleral venous pressure (normal: 10 mmHg)

Factors Affecting IOP

Factor	Association
Age	Increases with age
Sex	Higher in women
Race	Higher in Black individuals
Diurnal variation	Fluctuates throughout the day
Blood pressure	Directly proportional
Hormones	Corticosteroids increase IOP
Obesity	Higher IOP
Seasonal variation	Higher in winter
Drugs	Various effects
Posture	Rises in inverted position
Refractive error	Higher in myopia
Eye movement	Resistance increases IOP
Exercise	Transient decrease in IOP

Methods

Study Design and Participants:
A single-center, prospective, cross-sectional study was conducted in the School of Medical Sciences, University of Hyderabad, and Centre for Sight Eye Hospital, Hyderabad. Forty-eight eyes were enrolled: 15 normal controls, 17 PACG after YAG-PI, and 16 POAG diagnosed by standard clinical criteria. Inclusion criteria included age 30–90, no corneal pathology or other ocular surface disease, and consent to participate.

Procedures:
All subjects underwent comprehensive ocular examination, including refraction, slit lamp, IOP measurement (Goldmann applanation tonometer, Zeiss AT 020), gonioscopy, fundoscopy, pachymetry, and visual field testing (in glaucoma patients).

Baseline IOP was measured before mydriasis. Mydriasis was induced using one drop of 0.8% tropicamide and 5% phenylephrine (Itrop Plus), and IOP was measured again after 30 minutes.

Statistical Analysis:
Wilcoxon rank sum test was used for intra-group comparisons pre- and post-dilatation. The Mann-Whitney U test was used for inter-group comparisons. A p-value <0.05 was considered statistically significant.

Results

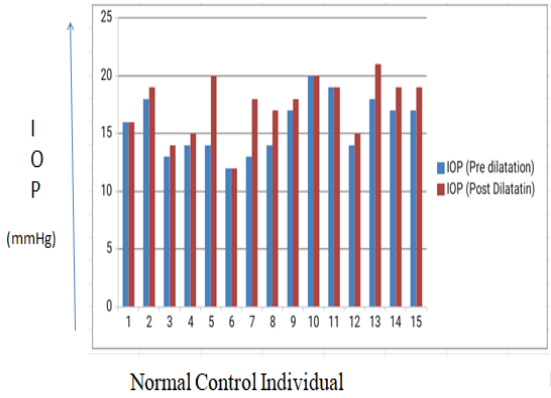
The study was done on total 47 eyes, out of them Normal control 15 eyes, PACG with YAG-PI procedure 17 eyes, and eyes with POAG was 16 in number.

	N	Minimum	Maximum	Mean	Std. Deviation
NC Pre Dilatation	15	12	20	15.733	2.53
NC Post Dilatation	15	12	21	17.466	2.55
PACG & YAG PI Pre Dilatation	17	12	22	16.058	2.63
PACG & YAG PI Post Dilatation	17	14	24	18.411	2.50
POAG Pre Dilatation	16	10	25	16.81	4.43
POAG Post Dilatation	16	14	30	19.43	4.48

105 ab . Description of Subject

106 **(A) Normal Controls (NC):-**

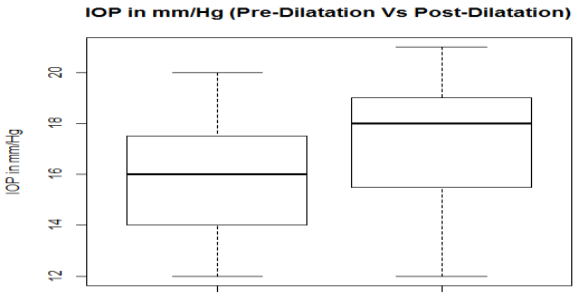
107 **Variation of IOP pre and post dilatation**



108

109 Tab. Variation of IOP pre and post dilatation in NC

110



111 **Population Distribution Plot:-** Tab. Box

112 plot of change in IOP of NC

113 Statistical Hypothesis Test:-

114 • Wilcoxon Test: Wilcoxon rank sum test with continuity correction.

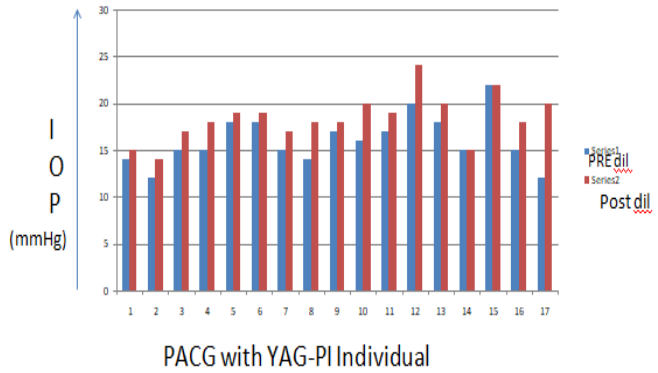
115 • W = 66.5

116 • p-value = 0.05721

- Alternative hypothesis: True location shift is not equal to 0
- Pearson's Correlation: [1] 0.7348842.

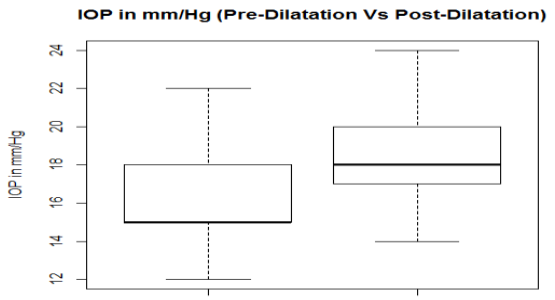
(B) PACG with YAG-PI

Variation of IOP pre and post dilatation:-



ab. Variation of IOP pre and post dilatation in PACG with YAG-PI

Population Distribution Plot:



Tab. Box plot of change in IOP of PACG with YAG-PI

Statistical Hypothesis Test:-

Wilcoxon test:

Wilcoxon rank sum test with continuity correction

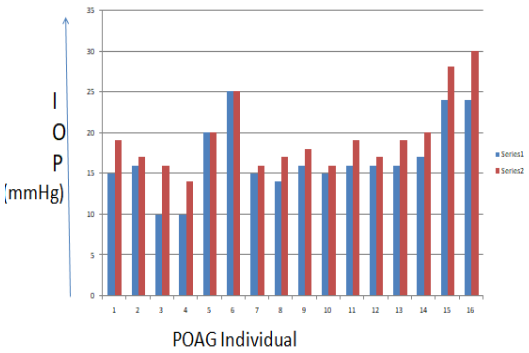
W = 72, p-value = 0.01217

Alternative hypothesis: true location shift is not equal to 0.

Pearson's Correlation:[1] 0.7172202.

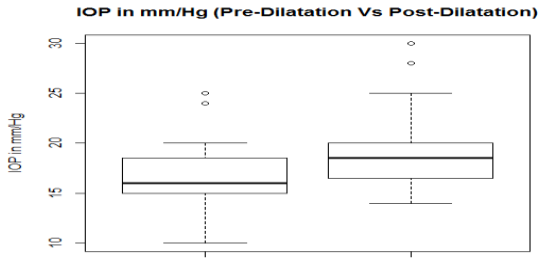
(C) POAG

Variation of IOP pre and post dilatation



Tab. Variation of IOP pre and post dilatation in POAG

Population Distribution Plot:-



Tab. Box plot of change in IOP in POAG

Statistical Hypothesis Test:-

- Wilcoxon Test: Wilcoxon rank sum test with continuity correction
- W = 73,
- p-value = 0.03798
- Alternative Hypothesis: true location shift is not equal to 0.
- Pearson's Correlation:[1] 0.909944

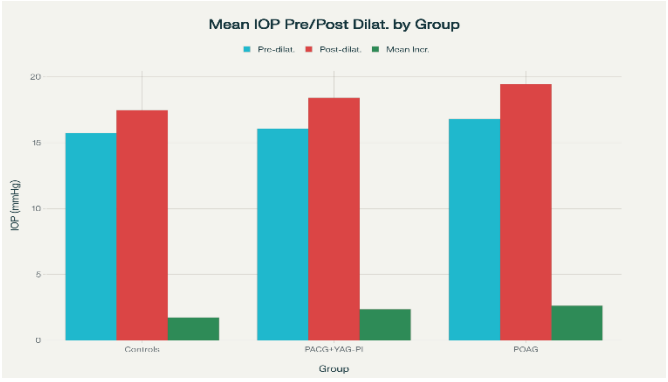
Discussion

Post-dilation IOP elevation was most pronounced in POAG and moderate in PACG post-YAG PI. The small sample size may have limited the power to detect inter-group differences. These results align with previous studies documenting IOP spikes post-mydriasis in glaucoma patients, supporting the need for IOP evaluation before dilatation, especially in at-risk populations.

Routine pre-dilatation IOP assessment is advocated, and clinicians should be vigilant for IOP elevations following mydriasis in glaucoma management.

Conclusion

Pharmacologic pupil dilation with tropicamide and phenylephrine causes a small but significant rise in IOP in PACG (post-YAG PI) and POAG eyes, but not in normal. It is prudent to record IOP prior to dilation, particularly in glaucoma patients, to avoid artifactual elevations and ensure patient safety.



Tab. Grouped bar chart showing mean IOP pre- and post-dilatation and mean increase for Controls, PACG + YAG-PI, and POAG groups

Group	Pre-dilatation	Post-dilatation	Mean Increase (±SD)
Controls	15.73	17.47	1.73 ± 1.83
PACG + YAG-PI	16.06	18.41	2.35 ± 1.93
POAG	16.81	19.44	2.62 ± 1.89

Tab. Mean IOP pre- and post-dilatation and mean increase for Controls, PACG + YAG-PI, and POAG groups

- Statistically significant IOP increases intra-group for PACG ($p = 0.012$) and POAG ($p = 0.038$).
- No significant difference in IOP rise between controls vs. PACG or POAG ($p = 0.509$, 0.453, respectively).

Acknowledgments

We thank the study participants, as well as faculty and staff at the School of Medical Sciences, University of Hyderabad and Centre for Sight Eye Hospital, Hyderabad, for their support.

Conflicts of Interest

No conflicts of Interest

References

1. Qian, C. X., Duperré, J., Hassanaly, S., & Harissi-Dagher, M. (2012). Pre- versus post-dilation changes in intraocular pressure: their clinical significance. Canadian Journal of Ophthalmology, 47(5), 448–452.

2. Levine, J. P., & Keshet, M. (2006). Comparing Change in Intraocular Pressure after Dilation with Tropicamide Alone versus Tropicamide and Phenylephrine. Investigative Ophthalmology & Visual Science, 47(13), 4465.

3. Shaw, B. R., & Lewis, R. A. (1986). Intraocular Pressure Elevation After Pupillary Dilation in Open Angle Glaucoma. Archives of Ophthalmology, 104(8), 1185–1188.

4. Pukrushpan, P., Tulvatana, W., & Kulvichit, K. (2005). Intraocular pressure change following application of 1% tropicamide for diagnostic mydriasis. Acta Ophthalmologica Scandinavica, 84(2), 268–270.