Original Research Article

The Postural changes in intraocular pressure in normal and glaucomatous eyes in Indian population

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Received: 20-10-2024 / Revised: 12-11-2024 / Accepted: 24-12-2024

Abstract

Introduction: Intraocular pressure (IOP) increases when changing from sitting to supine position flat without pillow with an average difference of 0.85 to 6.01mm of Hg. These postural changes of IOP have been found in normal persons, patients with ocular hypertension and normal tension glaucoma. The eye is relatively non-distensible, even small changes in the volume of aqueous humor may significantly change IOP. The increase in resistance in aqueous flow is thought to be the reason for higher IOP in supine compared to sitting position. The aim of this study is to analyze the Postural changes in intraocular pressure in normal and glaucomatous eyes of Indian population. **Method**: It was a prospective cross sectional study done in Armed Forces Medical College Pune, between June, 2022 to June, 2024 with sample sized of 60 people 30 controls (Normal) and 30 Primary open angle glaucoma). Patients underwent complete ocular examination. Two drops of Topical 2% propacaine were instilled. IOP measurements were taken by Parkin handheld tonometer in sitting and supine flat without pillow and supine with pillow positions at 10 minutes, 20 minutes and 30 minutes interval respectively. **Results:** The IOP difference between the sitting and supine flat position was significantly higher in the POAG than non-glaucoma subjects (5.0667±0.09 vs 6.01±0.85 mm Hg, P<0.001). The IOP difference between the sitting and supine with pillow positions was 1.3667±0.14 mm Hg for POAG and 2.8±0.34 mm Hg in non-glaucoma (P<0.001), While difference between supine flat and supine with pillow positions was 3.7±0.23 mm Hg in POAG and 3.2±0.51 mm Hg in non-glaucomatous patients (P<0.001). **Conclusions**: The rise in IOP due to change of posture from sitting to supine positions was significantly higher in glaucomatous patients.

Keywords: Intraocular pressure, Perkin hand head tonometer, Glaucoma.

Introduction

Posture is one factor that has a longer effect on intraocular pressure (IOP). It increases when changing from sitting to supine position with an average difference of of 0.85 to 6.01mm of Hg[1,3]. "This postural effect on IOP is greater in eyes with glaucoma[4,5] and persists even after successful trabeculectomy[6,7]. These postural changes of IOP have been found in normal persons, ocular hypertensives and normal tension glaucomas[4-6]. Elevation of episcleral venous pressure on lying down, increases aqueous outflow resistance and causes rise in IOP. Whole body head down tilt leads to a further increase in IOP, which correlates with degree of inversion[8] is greater in glaucomatous eyes[9,10]. Glaucoma caused by raised episcleral venous pressure results in a direct effect on IOP. "The ultimate IOP is influenced by the production and outflow of aqueous which is majorly balanced by episcleral venous pressure. More than 80% of aqueous outflow occurs through Schlemm's canal into episcleral veins[11-15]. The eye is relatively non-distensible, even small changes in the volume of aqueous may significantly change IOP. "The IOP postural response depends on arterial and venous vascular changes[16-20].

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The aim of this study was to analyze the effects of Postural changes in intraocular pressure in normal and glaucomatous eyes of Indian population.

Methods

A prospective cross sectional study was done in Eye Outpatients Department, Armed Forces medical College, Pune where 30 cases of primary open angle glaucoma and 30 controls (Normal) were taken. It was studied between June 2022 and June 2024. "The inclusion criteria were newly diagnosed cases of POAG,

1. Open anterior chamber angle(Shaffer's grade 3 and 4 in all quadrants)
2. Raised IOP(≥ 22mmhg), this is the true IOP after accounting for central thickness (pachymetry)
3. A vertical cup-disc ratio of ≥ 0.6 or asymmetry of disc cupping equal to or greater than 0.2 with or without the following disc changes: a rim notching or thinning of the rim, disc haemorrhage or violation of the ISNT (inferior, superior, nasal, temporal) rule on dilated fundoscopy using +90D in one or both eyes.
4. Characteristic glaucomatous visual field defect(such as nasal step, paracentral scotoma, temporal wedge defect, siedel scotoma, arcuate scotoma, double arcuate scotoma by using humphery field analyzer

5. Non-glaucomatous(Normal): patients is one who in each eye meet the following criteria:

a. Vertical cup-disc ratio of <0.6,no disc asymmetry of >0.2,no rim notching or thinning of the rim, no disc haemorrhage or violation of the ISNT rule and no disc pathology, with pink rim seen on dilated fundoscopy using +90D.

b. True IOP of <22 mm Hg after pachymetry

The Exclusion criteria includes

a) Participants < 30 years
b) Diagnosed with POAG before this study
c) Types of glaucoma other than POAG
d) Previous ocular surgeries
e) Anterior segment pathologies such as acute or chronic uveitis
f) Any corneal abnormality that would prevent reliable IOP measurement such as corneal opacity
g) Diabetes
h) Hypertension
i) Subjects on medications known to influence IOP.

Importance of the test and description of the procedure was given to all patients and the informed consent was taken. Patients underwent complete ocular examination consisting of best corrected visual acuity, slit lamp examination of anterio segment, optic nerve head examination, pachymetry, goniscopy. SITA Standard 24-2 Humphrey's automated perimetry was done.

Two drops of Topical 2 % propacaine were instilled in the eyes. IOP measurements were taken with the help of Parkin handheld tonometer first in the sitting position,supine position with pillow and then in supine positions without pillow at 10 minutes, 20 and 30 minutes interval respectively. Topical antibiotic drop was put after each measurement.

Results were tabulated and statistical analysis was done. Descriptive and correlation significance was found out.

Results

Total 60 cases were included in this study where 30 were newly diagnosed primary open angle glaucoma (POAG) subjects and 30 were Normal eye (controls).

In POAG group, the male were 14 and female 16 in number while in Control group 12 were female and 18 patients were in male each respectively (Chi-square test, p=0.3006).

- The IOP difference between the sitting and supine flat position was significantly higher in the POAG than non-glaucoma subjects (5.0667±0.09 *vs* 6.01±0.85 mm Hg, *P*<0.001).
- The IOP difference between the sitting and supine with pillow positions was 1.3667±0.14 mm Hg for POAG and 2.8±0.34 mm Hg in non-glaucoma (*P*<0.001),
- While difference between supine flat and supine with pillow positions was 3.7±0.23 mm Hg in POAG and 3.2±0.51 mm Hg in non-glaucomatous patients (*P*<0.001).

Table 1:Posture versus group comparison

Posture	POAG Group	Control group	P value
Sitting & Supine flat position	6.01±0.85	5.0667±0.09	<0.001
Sitting & supine with pillow	2.8±0.34	1.3667±0.14	< 0.001
Supine flat & supine with pillow	3.7±0.23	3.2±0.51	<0.001

Table difference in mean IOP measurements and P value.

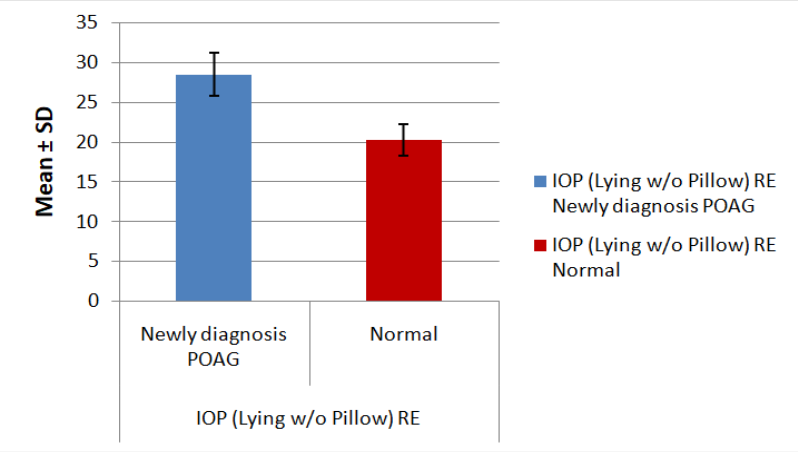

Fig 1:Mean versus IOP(Lying w/o pillow)

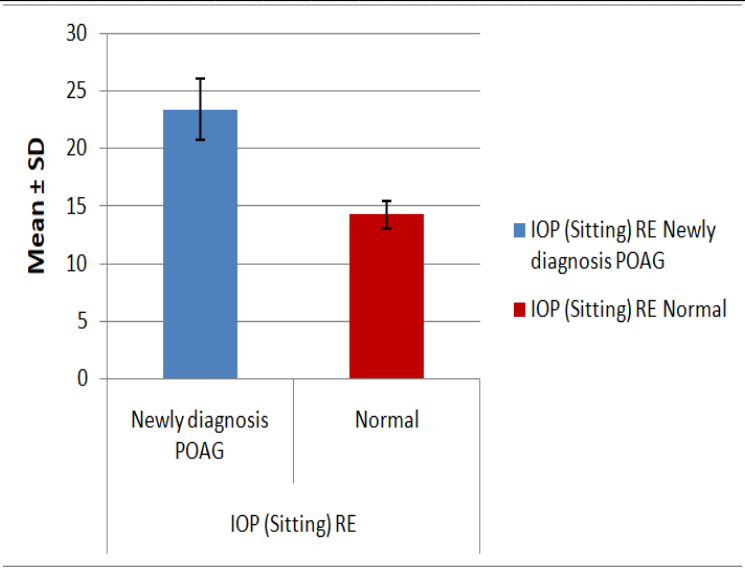

Fig 2: Mean versus IOP(sitting)

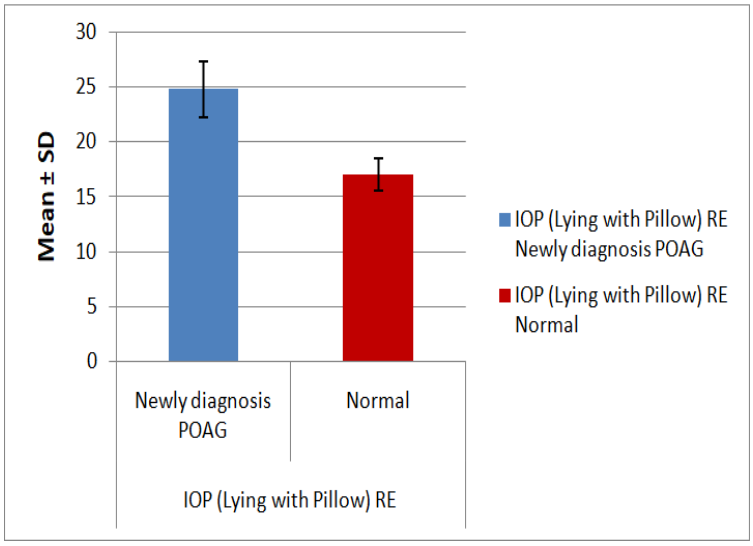

Fig 3: Fig 1:Mean versus IOP(Lying with pillow)

Discussion

Body position is important factor in determining the intraocular pressure because the eye is relatively non distensible and even small changes in volume significantly change IOP. Moreover, uveal engorgement may also increase the perfusion of the ciliary body, increase in production of aqueous thereby increasing IOP. Weber & Price et al claimed that with posture, there is an increase in diastolic arterial pressure resulting in dilatation & increased perfusion of the ciliary processes causing increased formation of aqueous.

In a study conducted by J Parsley et al[8], forty-six eyes with POAG and 24 eyes which had previously undergone trabeculectomy for POAG were studied and the postural response of the intraocular pressure was compared to that of 70 normal eyes. In all three groups, the greatest rise in IOP occurred when the subject changed from the sitting to the lying position. In a study by A S Kothari et al, IOP was higher in hypertensive patients and postural response of IOP was significantly higher in these patients as compared to controls.

Our findings are similar to both these studies. IOP has been reported to be higher with the patient supine without pillow than when sitting and supine with pillow. While awake, individuals usually are either standing or sitting and one third or one quarter of the day is spent in supine position, asleep. When sitting or standing, the eye is 30 cm higher than the heart. However, when the patient is supine, the eye and the heart are at almost the same level. This gap in height is thought to affect the episcleral venous blood flow. Orbital venous pressure increases quickly, depending on posture because of numerous interconnections between the orbital drainage routes and the lack of venous valves in the orbit. This causes an increase in the resistance to aqueous outflow.

A decrease in mean arterial pressure (MAP) or an increase in IOP can decrease ocular perfusion. Systolic blood pressure (BP) and IOP decrease significantly from supine to sitting position where as diastolic BP increases significantly. Changes in IOP also occur with head down position and are believed to be due to either increase in episcleral venous pressure, increased aqueous production with

increased ciliary body blood flow, choroidal vascular engorgement or a barorecepter type reflex phenomenon.

Phyburg and Weinreb found that IOP dramatically increased to more than 30 mm of Hg and retinal arterioles markedly constricted with the head down vertical position. Values in all patients with autonomic dysfunctions were higher in the supine than in the standing position.

In the Barbados Eye Studies, Sun Yuh Wu et al have stated that IOP changes were positively associated with male sex, hypertension, diabetes, higher systolic and diastolic blood pressure. A 10 mm Hg increase in systolic or diastolic blood pressure was associated with an approximately 0.2 mm Hg or 0.4 mm Hg increase in IOP. Part of the nocturnal increase in IOP has been attributed to a change from sitting to supine position with sleep. Altered retrobulbar hemodynamics have been found in glaucoma patients compared to controls by stimulating nocturnal postural change from sitting to supine position.

Conclusion

There are greater variations in posture induced IOP occurred in POAG patients than non-glaucomatous subjects. The posture induced IOP variation is lowest in the sitting position and highest in the supine flat position. Evaluation of posture induced IOP changes may be an important tool in the management of glaucoma.

References

1. David R, Zangwill L, Stone D, et al. Epidemiology of intraocular pressure in a population screened for glaucoma. Br. J. Ophthalmol. 1987;71(10):766-71.
2. Leske MC. • e epidemiology of open-angle glaucoma; a review. Am J Epidemiol. 1983;118:116-9.
3. Spierer A. Eisentein Z. • e role of increased intraocular pressure on up gaze in the assessment of Grave's ophthalmopathy. Ophthalmology. 1991;98(10):1491-4.
4. Anderson DR. Grant MW. e in€ uence of position on intraocular pressure. Invest Ophthalmol Vis Sci. 1973;12:204-12.
5. Yamabayashi S. Aguilar Rn. Hosoda M. et al. Positional change in intraocular and blood pressure in ocular hypertension and tension glaucoma. Br J Ophthalmol. 1991;75(11):652-5.
6. Parsley J. Powell RG. Keithley SJ et al. Postural response of intraocular pressure in chronic open angle glaucoma following trabeculectomy. Br J Ophthalmol. 1987;71:494-6.
7. Wilensky JT, Zeimer RC, Gieser DK, Kaplan BH. • e e• ects of glaucoma . ltering surgery on the variability of diurnal intraocular pressure. Trans Am Ophthalmol Soc. 1994;92:337-383.
8. Linder BJ. Trick GL. Wolf ML. Altering body position a• ects intraocular pressure and visual function. Invest Ophthalmol Vis Sci. 1988;29(10):1492-7.
9. Weinreb RN, Cook J, Friberg TR: E• ect of inverted body position on intraocular pressure. Am J Ophthalmol. 1984, 98(6):784-7.
10. Chiquet C. Custaud M-A, Le troan A-et al. Changes in intraocular pressure during prolonged (7-day) head-down tilt bedrest. J Glaucoma 2003;12(3):204-8.
11. Friberg TR, Sanborn G, Weinreb RN. Intraocular and episcleral venous pressure increase during inverted posture. Am J Ophthalmol. 1987;103:523–6.
12. Townsend DJ, Brubaker FJ. Immediate e• ect of epinephrine on aqueous formation in the normal human eyes measured by € uorophotometry. Invest Ophthalmol Vis sci. 1980;19(3):256-66.
13. Gabelt BT, Kaufman PL. Aqueous humor hydrodynamics. In: Kaufman PL, Alm A, eds. Adler's physiology of the eye. St. Louis: Mosby; 2003:p237.
14. Fine BS. Structure of the trabecular meshwork and the canal of Schelemm. Trans Am Acad Ophthalmol Otolaryngol. 1966;70(5):777-90.
15. Tripathy RC. Mechanism of the aqueous out€ ow across the trabecular wall of schlemm's canals. Exp Eye Res 1971;11(1):116-21.
16. Emi K, Pederson JE, Toris CB. Hydrostatic pressure of the suprachoroidal space. Invest Ophthalmol Vis Sci. 1983;24(6):725-6.
17. Macri FJ: Interdependence of venous and eye pressure. Arch ophthalmol. 1961;65:442-49.
18. Moses RA. Grodzki WJ Jr. Choroid tension and facility of aqueous € ow. Ophthalmol Vis Sci. 1977;16(11):101-62.
19. Bill A. Blood Circulation and € uid dynamics in the eye. Physsio Rev.1975;55(3):383-417.
20. Blondeau P, Tetrault JP, Papamarkakis C. Diurnal Variation of episcleral venous pressure in healthy patients: a pilot study. J Glaucoma 2001;10(1):18-24.

Conflict of Interest: Nil

Source of support: Nil