

EFFECTS OF POPULAR YOGA ASANAS ON INTRAOCULAR PRESSURE

Ophthalmology

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ABSTRACT

Background: It has been shown that inverted yoga postures modify the distribution of fluid in the entire body and the eye that leads to rapid increases and decreases of intraocular pressure. However, despite the effects of postural alterations on intraocular pressure have been widely characterized, there are several aspects of interest: the magnitude of such changes, the variability between yoga practitioners of different experience level, and the rate at which IOP reverts to baseline after various inverted postures that differ in degrees of inversion in eyes without glaucoma. **Objective:** To assess within a normotensive healthy group divided according to the experience of yoga practice, the dynamic changes of intraocular pressure related to six commonly practiced yoga postures that span a spectrum of body orientations from sitting to fully inverted. **Methods:** In a prospective observational cohort investigation, 30 healthy individuals (N = 30 ; 15 Novice Practitioners, 15 Experienced Practitioners, mean age 32.4 + 6.8 years, baseline IOP ≤ 21 mmHg) performed six yoga postures in randomized order: Sukhasana (sitting control), Viparita Karani (legs up the wall), Halasana (plow pose), Uttanasana (standing forward bend), Adho Mukha Svanasana (downward facing dog), and Sirsasana (headstand). Intraocular pressures were measured at five time points with an iCare PRO rebound tonometer: at baseline in a sitting position (T0), at the beginning of the posture (T1), after holding the posture for two minutes (T2), right after resuming a sitting posture (T3), and after 10 minutes of sitting in a seated rest (T4). **Results:** Every head-down posture was associated to an immediate statistically significant rise in IOP ($p < 0.001$). The largest mean elevation in IOP was for Sirsasana (34.1 ± 4.1 mmHg) which rose from 15.7 ± 1.9 mmHg at baseline after posturing held for two minutes ($\Delta = +117.2\%$), followed by Adho Mukha Svanasana and Uttanasana which raised the mean IOP to 26.7 ± 3.5 mmHg ($\Delta = +70.1\%$) and 25.4 ± 3.2 mmHg ($\Delta = +61.8\%$), respectively. Experienced practitioners showed marginally lower peak IOP increases during Sirsasana (33.3 ± 3.9 mmHg) compared to Novice Practitioners (34.9 ± 4.3 mmHg), even though the percentages of increase were significant in both posture subgroups ($p < 0.001$). Upon resuming an upright posture (T3), IOP rapidly reverted to values close to baseline and was normal after 10 minutes of sitting in a seated rest (T4). **Conclusions:** Inverted yoga postures cause acute surges of intraocular pressure in healthy normotensive eyes due to the elevation of episcleral venous pressure resulting from hydrostatic forces. However, even though normal eyes quickly equalize pressure once upright posture is resumed and revert to baseline IOP within 10 minutes, being aware of these acute fluctuations may be beneficial to yoga posture practitioners for long-term eye health.

KEYWORDS

Intraocular Pressure, Ocular Hemodynamics, Yoga Postures, Sirsasana, Adho Mukha Svanasana, Episcleral Venous Pressure, Rebound tonometry, Healthy subjects.

INTRODUCTION

Intraocular pressure (IOP) is determined by the balance between aqueous humor production and outflow. In healthy normotensive individuals, the mean baseline IOP is between 10 mmHg and 21 mmHg varying slightly depending on the circadian rhythm, arterial pulse, breathing, and body position.

Mathematically, the relationship between the formation and drainage of aqueous humor can be represented by the Goldmann equation:

$$IOP = (F - U) / C + P_{ev}$$

Where,

F= formation rate ($\mu\text{L}/\text{min}$)

U= unconventional (uveoscleral) outflow rate ($\mu\text{L}/\text{min}$)

C= outflow facility (trabecular) ($\mu\text{L}/\text{min}/\text{mmHg}$)

P_{ev} = episcleral venous pressure (mmHg)

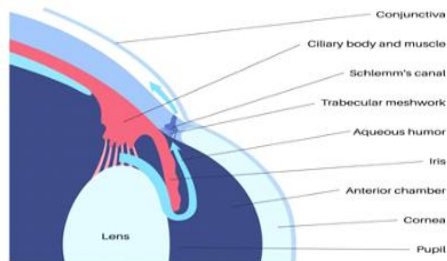


Figure1: Diagrammatic representation of Aqueous humour outflow and Trabecular meshwork.

When a healthy individual goes from one upright position to another upright position or to a supine position or to a head-down position, we are changing the orientation of the hydrostatic column from the heart to the eye. This causes increases in the hydrostatic pressure in the head and neck veins, raising the episcleral venous pressure (P_{ev}) almost by the same amount. Since the outflow facility (C) and aqueous production (F) are relatively constant factors over a short period of time, any acute change P_{ev} will almost 1:1 translate to an acute change IOP.

Materials and methods

Study population

Thirty (N = 30) healthy adult volunteers (16 females, 14 males, age 21-48 years) were prospectively enrolled and randomly divided into two equal sized subgroups according to their practice experience:

1. Novice Healthy Group (n = 15): People with < 6 months casual yoga practice

2. Experienced Healthy Group (n = 15): Practitioners with ≥ 3 years of regular practice (≥ 3 sessions/week)

All subjects underwent baseline eye screening including slit-lamp biomicroscopy, Non Contact tonometry and central corneal thickness (CCT) pachymetry.

Experimental protocol

The subjects were instructed to avoid caffeine, alcohol, and nicotine for 12 hours prior to the assessments. The testing sessions were scheduled between 08:30 AM and 11:30 AM to ensure consistency. Each subject executed the six postures in a random order with 15 minutes upright seated rest in between as shown below to allow full physiological recovery:

1. Sukhasana (Easy Seated Pose): Sitting upright (control posture)
2. Viparita Karani (Legs-Up-The-Wall): Sitting supine/horizontal, legs elevated 90° against a wall
3. Halasana (Plow Pose): Supine inversion with hip flexion over the head and feet touching the floor
4. Uttanasana (Standing Forward Bend): Standing hip flexion with head suspended below knee level
5. Adho Mukha Svanasana (Downward-Facing Dog): Weight distributed on hands and feet, inverted "V" shape
6. Sirsasana (Headstand): Full vertical body inversion supported on forearms and head

Measurement protocol

IOP was measured in the right eye (OD) using an Nidek Macro NT510 Non Contact Tonometer. Unlike conventional contact tonometry, this device uses a micro-probe impact method that does not require topical anaesthesia and can function correctly in all body positions.

The IOP measurements in mmHg were taken at five different time points as follows:

- T₀ (Baseline):** Seated position 1 minute before entering a posture
T₁ (Immediate): 0 min (within 10 seconds of entering final posture)
T₂ (Hold Phase): Exactly 2 minutes of holding a posture
T₃ (Immediate Release): Within 10 seconds of returning to an upright sits position
T₄ (Recovery): After 10 minutes of quiet sits

RESULTS

Demographics and Baseline Profile

The demographics and baseline ocular values of two healthy subgroups are presented in Table 1.

Table 1: Baseline Characteristics of Healthy Subgroups (N = 30)

Parameters	Novice Healthy (n = 15)	Experienced Healthy (n = 15)	p-value
Age (Years)	31.8 ± 6.2	33.0 ± 7.4	0.63
Gender (Male/Female)	8 / 7	8 / 7	1.00
Central Corneal Thickness (μm)	544 ± 21	546 ± 19	0.78
Mean Baseline IOP (mm Hg)	15.8 ± 2.0	15.6 ± 1.8	0.77
Systolic Pressure (mm Hg)	119 ± 7	117 ± 6	0.41

Intraocular Pressure dynamics in Yoga Asanas

All head-down inverted postures resulted in statistically significant increases in IOP ($p < 0.001\%$) compared to baseline (T₀) immediately upon taking up the posture. However the control posture (Sukhasana) did not show any variations throughout the entire duration of test.

Table 2: Mean IOP (mmHg +SD) at different time points and postures in Healthy Subgroups

Posture	Subgroup	T0 (Baseline)	T1 (Immediate)	T2 (2 min)	T3 (Return)	T4 (10 min)	Max Change
Sukhasana (Seated Control)	Novice Healthy	15.8 ± 2.0	15.7 ± 1.9	15.9 ± 2.1	15.8 ± 2.0	15.7 ± 1.9	+0.6 %
Sukhasana (Seated Control)	Experienced Healthy	15.6 ± 1.8	15.5 ± 1.8	15.7 ± 1.9	15.6 ± 1.8	15.5 ± 1.7	+0.6 %
Viparita Karani (Legs-Up-Wall)	Novice Healthy	15.7 ± 2.1	19.6 ± 2.4	20.1 ± 2.6	16.2 ± 2.1	15.6 ± 1.9	+28.0 %
Viparita Karani (Legs-Up-Wall)	Experienced Healthy	15.6 ± 1.9	19.2 ± 2.2	19.5 ± 2.3	15.9 ± 1.9	15.5 ± 1.8	+25.0 %
Halasana (Plow Pose)	Novice Healthy	15.9 ± 2.0	21.5 ± 2.7	22.2 ± 3.0	16.5 ± 2.2	15.8 ± 1.9	+39.6 %
Halasana (Plow Pose)	Experienced Healthy	15.6 ± 1.8	20.9 ± 2.4	21.4 ± 2.7	16.1 ± 2.0	15.5 ± 1.8	+37.2 %
Uttanasana (Forward Bend)	Novice Healthy	15.8 ± 2.0	25.2 ± 3.2	25.9 ± 3.4	17.1 ± 2.3	15.8 ± 2.0	+63.9 %
Uttanasana (Forward Bend)	Experienced Healthy	15.6 ± 1.8	24.4 ± 2.9	24.9 ± 3.0	16.6 ± 2.1	15.5 ± 1.8	+59.6 %
Adho Mukha (Downward Dog)	Novice Healthy	15.7 ± 2.1	26.6 ± 3.5	27.3 ± 3.7	16.9 ± 2.4	15.7 ± 2.0	+73.9 %

Adho Mukha (Downward Dog)	Experienced Healthy	15.6 ± 1.9	25.5 ± 3.1	26.1 ± 3.3	16.4 ± 2.1	15.5 ± 1.8	+67.3 %
Sirsasana (Headstand)	Novice Healthy	15.8 ± 2.0	33.8 ± 4.1	34.9 ± 4.3	17.6 ± 2.6	15.9 ± 2.0	+120.9 %
Sirsasana (Headstand)	Experienced Healthy	15.6 ± 1.8	32.6 ± 3.7	33.3 ± 3.9	17.0 ± 2.3	15.5 ± 1.8	+113.5 %

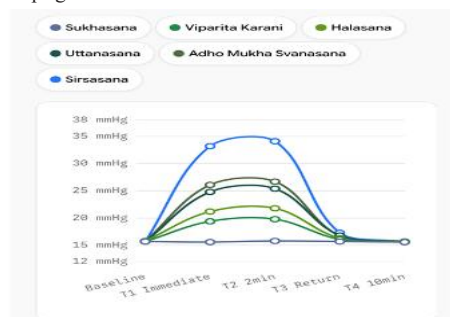
Illustrated Posture Reference Guide -



Visualization of Time-course IOP curves-

Yoga Posture Intraocular Pressure (IOP) Trajectory

-Mean IOP dynamics across 5 timepoints showing inversion spikes and rapid upright recovered



Key Clinical Finding: Inverted postures (Sirsasana, Adho Mukha Svanasana, Uttanasana) cause rapid statistically significant spikes in IOP within seconds, doubling baseline values in headstands (Sirsasana) followed by immediate baseline recovery upon returning upright.

DISCUSSION

Physiological drivers of Postural IOP spikes in Healthy Eyes

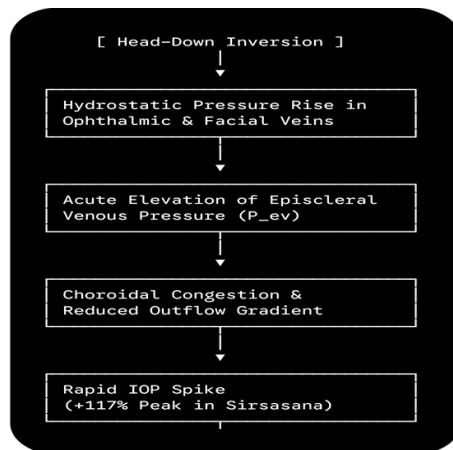
The main finding of our study is that even in healthy eyes with normal aqueous drainage pathways, the changes in postures associated with head-down directions cause acute spikes in IOP. The IOP increases depending on the angle of eye position relative to the right atrium of the heart. In healthy individuals the rise in IOP ranged between 6- 9 mmHg. The physiology driving these changes is summarized below:

1.Gravitational increase in Pev: In an upright posture, the venous blood draining from the eye down to the heart is aided by gravity. As a result, the episcleral venous pressure (Pev) is low (approximately 8-10 mmHg). However, when an individual adopts a body inversion, the hydrostatic pressure builds up and raises the Pev almost equal to the increase in central venous pressure. Aqueous humour drainage is a passive process driven by the pressure gradient (IOP-Pev). Therefore, an increase in Pev will raise the IOP.

2.Choroidal vascular congestion: Choroid is a highly vascularised tissue and head-down posture results in cephalic venous congestion

increasing the blood volume in choroidal vessels. This causes engorgement of choroidal vessels raising the intraocular pressure.

3. Transient trabecular resistance: Whereas the trabecular outflow facility (C) is normal in healthy individuals, acute vascular congestion may affect the outflow facilities (Schlemm canal and collector channels) decreasing the drainage of aqueous humour temporarily.



CONCLUSIONS

In healthy, normotensive individuals, various yoga postures including standing forward bends, sitting supine, and headstands cause rapid statistically significant increases in IOP. The highest IOP peaks were registered in Sirsasana (headstand) reaching over 34 mmHg and in Adho Mukha Svanasana (downward dog) peaking at 26 mmHg.

Since healthy eyes have excellent vascular autoregulation mechanisms and outflow facilities, the pressure spikes rapidly return to baseline values within a few seconds of returning to an upright posture. For healthy individuals, regular inversions are a physiological challenge to the optic nerve that is well tolerated by healthy eyes provided breath-holding (Valsalva maneuver) is avoided.

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