





The Effect of Specific Techniques of Nasal Breathing [Pranayama] on Intra-Ocular Pressure in Normal Individuals, a Randomized Trial

Alisha Kulkarni ^{1,*}, Yogish Kamath ^{1,*}, Lavya Shetty ², Neetha I R Kuzhuppilly ¹

¹Department of Ophthalmology, Kasturba Medical College Manipal, Manipal Academy of Higher Education, Manipal, Karnataka, India; ²Division of Yoga, Centre for Integrative Medicine & Research, Manipal Academy of Higher Education, Manipal, Karnataka, India

*These authors contributed equally to this work

Correspondence: Neetha I R Kuzhuppilly, Department of Ophthalmology, Kasturba Medical College Manipal, Manipal Academy of Higher Education, Manipal, Karnataka, 576104, India, Tel +91 98861 61979, Fax +91-820-2571934, Email cinnineetha@gmail.com; neetha.kir@manipal.edu

Purpose: Glaucoma is an optic neuropathy where intraocular pressure is the only modifiable risk factor. Yoga is thought to adversely affect intra-ocular pressure (IOP) but we do not know if yogic breathing exercises can influence IOP. With this study, we aimed to determine the effect of specific nasal breathing techniques on intra-ocular pressure in normal individuals.

Patients and Methods: One hundred and sixty-four normal subjects were randomly assigned to one of four specific breathing groups - right nostril breathing (RNB), left nostril breathing (LNB), alternate nostril breathing (ANB), normal breathing (NB). The IOP was measured in both eyes at baseline and following the breathing exercise; and the change was analyzed.

Results: Eighty-five women and 79 men participated and there was no significant difference in baseline age or IOP between the groups. In RNB, IOP reduced significantly in both right and left eyes, from 14.3 ± 3.0 mmHg to 13.9 ± 2.6 mmHg, ($p=0.022$) and from 14.7 ± 3.2 mmHg to 14.2 ± 3 mmHg ($p=0.016$) respectively. In LNB, there was no significant IOP change in the right eye, whereas in the left eye, there was a significant reduction from 14.2 ± 2.7 mmHg to 13.3 ± 2.5 mmHg ($p < 0.0001$). There was no significant IOP change in ANB and NB.

Conclusion: Specific breathing techniques like right and left nostril breathing, alternate nostril breathing are safe and do not raise IOP in normal subjects. Additionally, right and left nostril breathing techniques have a beneficial effect of lowering IOP.

Keywords: eye, glaucoma, yoga, risk-factor, breathing exercises

Introduction

Glaucoma is the second most important cause of blindness in the world. It is a condition of the eye characterized by optic neuropathy and corresponding visual field defects, where raised intraocular pressure (IOP) has been implicated as the most common risk factor. IOP is also the only variable in the pathogenesis of glaucoma, which can be controlled and/or lowered by medical or surgical treatments.

Yoga has been shown to have beneficial effects on general health.^{1,2} Conversely, over the years, the effect of yoga on the eye has been thought to be ambiguous.³⁻⁷ Various problems in the eye were attributed to yogic practices.^{8,9} A frequent question encountered during glaucoma management is whether the patient can continue practicing yoga. In recent years interest has been rekindled in yoga and the eye, especially yoga and intraocular pressure.^{7,10-14}

Various yogic breathing techniques have been shown to alter the brain hemisphere activity, and influence the autonomic nervous system.¹⁵ Right nostril breathing is thought to increase the sympathetic activity and left nostril breathing brings about dominance of parasympathetic activity.^{15,16} It is known that the autonomic nervous system has a regulatory effect on IOP by modifying the production or drainage of aqueous humor. Whether yogic breathing exercises can alter IOP, whether they are safe or whether they can be used as additional IOP lowering methods in glaucoma are

areas that have not been studied well. Therefore, we carried out this study to determine the effect of different techniques of nasal breathing on intraocular pressure in normal individuals.

Materials and Methods

This was a prospective randomized multi-arm clinical trial conducted at a tertiary hospital from February 2020 to December 2021, which was approved by the Institutional ethical committee (IEC approval number: 595/2019). It was registered with Clinical Trials Registry - India (registration number: CTRI/2020/02/023098, registration date: 03/02/2020). The tenets of Declaration of Helsinki were adhered to and informed consent was obtained from all participants.

Inclusion and Exclusion Criteria

Participants for the study were enrolled from among the patients or their bystanders visiting the Ophthalmology outpatient department of our hospital, between ages of 18 and 80 years. Participants with the following were excluded - shallow anterior chamber, angle closure disease, participants already on antiglaucoma medications, participants who consumed one liter or more fluids in the last one hour, gross deviated nasal septum, nasal polyps, any other nasal obstruction, rhinitis, significant respiratory disorders, hypertension (on beta-blockers or any other drugs affecting the autonomic nervous system), cerebro-vascular disorders, autonomic nervous system disorders like orthostatic hypotension, postural orthostatic tachycardia syndrome.

Detailed Description of Study Process

A total of 164 normal subjects were included in the study who were allocated to their intervention groups using stratified random block randomization (Figure 1). The participants were divided into 41 blocks of four participants, each of whom were assigned to one of the intervention groups. The groups were Right nostril breathing group (RNB), Left nostril breathing group (LNB), Alternate nostril breathing group (ANB), Normal breathing group (NB). The participants were made to sit comfortably and written informed consent was obtained. Pulse and blood pressure (BP) were recorded followed by measurement of IOP by Goldmann applanation tonometer (GAT) was performed. The IOP was measured using a well-calibrated GAT ensuring that all sources of error were minimized. The right eye IOP was measured first and then the left eye, readings were taken until three consecutive readings were within one mmHg.

The participants were then taken to a well-ventilated and well-sanitized room and asked to remove their masks and then carry out the breathing exercise for five minutes. They were then instructed to put the mask back on and immediately taken to the examination room for IOP, pulse and BP measurement. The same examiner measured the IOP before and after the exercise. As our study was conducted during the COVID-19 pandemic, all IOP measurements were done with a mask on. The enrollment of participants, randomization and assignment to intervention groups were done by a single investigator. The investigator who measured the IOP before and after the exercise was blinded to the intervention.

The primary outcome measure was intraocular pressure change following the breathing exercise. The secondary outcome measure was the effect on pulse and blood pressure.

Breathing Exercise Instructions

In the right nostril breathing group, the participants were instructed to firmly close the left nostril with index finger and breathe normally from the right nostril for five minutes. In the left nostril breathing group, the participants were asked to firmly close the right nostril with index finger and breathe normally from the left nostril for five minutes. In alternate nostril breathing group, the participants were asked to breathe in normally from the right nostril (keeping left nostril closed) and breathe out from the left, and then breathe in from the left (keeping right nostril closed) and breathe out from the right nostril. They were asked to continue this process for the next five minutes. In the normal breathing group, the participants were instructed to breathe normally through both nostrils for five minutes. In all the groups, subjects were instructed not to breathe forcefully or hold their breath during the exercise.

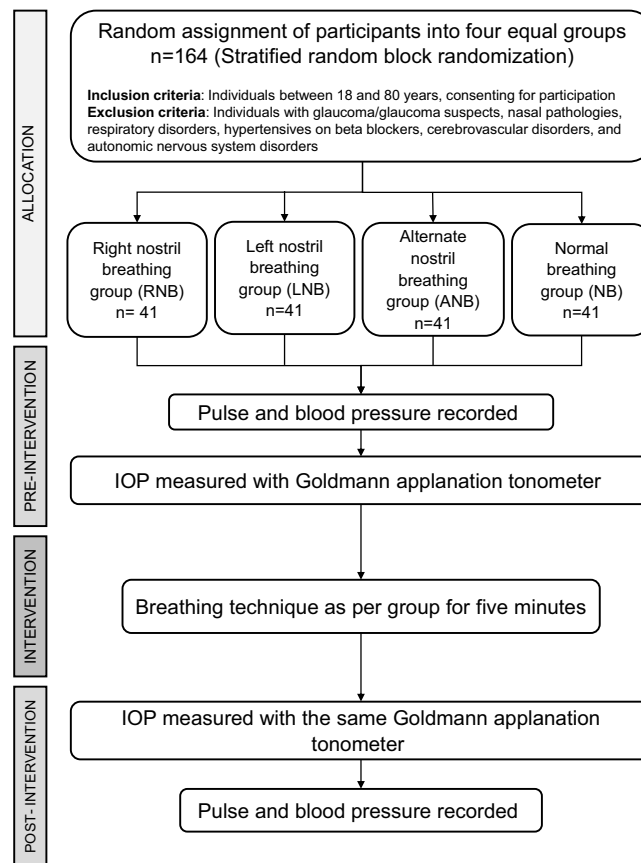


Figure 1 Flowchart depicting the participant flow through the study process.

Abbreviation: IOP, intraocular pressure.

Statistical Analysis

A minimum sample size of 41 participants in each group was calculated for a power of 80% at 95% confidence interval to detect a difference in outcome of one mmHg. The collected data were analyzed with IBM SPSS Statistics for Windows, Version 23.0. (IBM Corp., Armonk, NY, USA). To describe the data, descriptive statistics, frequency analysis and percentage analysis were used for categorical variables; the mean with standard deviation and median with interquartile ratio (IQR) were used for continuous variables. To detect significant difference between the bivariate samples in Paired groups the Wilcoxon signed rank test was used and for multivariate analysis, the Kruskal Wallis test. With all these statistical tools the probability value less than 0.05 was considered as significant.

Results

Baseline Data

Out of the 164 participants, 85 (51.8%) were women, and 79 (48.2%) were men of mean age 45.3 ± 15.4 years. The gender and age distribution across the groups are given in Table 1. There was no significant difference in the baseline intra-ocular pressures of either the right eye or left eye across the groups ($p=0.724$ and $p=0.877$ respectively).

Right Nostril Breathing Group

In RNB group, the mean IOP in the right eye reduced significantly to 13.9 ± 2.6 mmHg from 14.3 ± 3.0 mmHg after the breathing exercise ($p=0.022$). In the left eye, the mean IOP reduced to 14.2 ± 3 mmHg from 14.7 ± 3.2 mmHg, $p=0.016$. Both eyes combined, there was a reduction in IOP of 0.5 ± 1.2 mmHg ($p=0.001$ with Wilcoxon signed rank test). Out of 41 subjects in RNB, the right eye pressure either reduced or remained unchanged in 29 (71%) subjects. In the left eye, in 35 (85%) subjects the IOP either reduced or remained unchanged.

Table 1 Baseline Characteristics Across the Groups

		RNB Group	LNB Group	ANB Group	NB Group
Total	Women	22	20	23	20
	Men	19	21	18	21
Age (yrs)	Mean	45.3	43.7	46.5	45.4
	Median	44.0	44.0	49.0	48.0
	Standard deviation	16.2	15.1	16.4	13.4
	25th percentile	28.5	30.5	30.5	35.0
	75th percentile	57.5	55.5	61.5	56.0
Right eye pre-intervention IOP ^a (mean \pm SD)		14.3 \pm 3	13.9 \pm 2.9	14.0 \pm 2.6	14.4 \pm 2.9
Left eye Pre-intervention IOP ^b (mean \pm SD)		14.7 \pm 3.2	14.2 \pm 2.7	14.1 \pm 2.6	1.1 \pm 3.2

Notes: ^aStatistically not significant with $p=0.724$, ^bstatistically not significant with $p=0.877$ (by Kruskal Wallis test).

Abbreviations: RNB, right nostril breathing; LNB, left nostril breathing; ANB, alternate nostril breathing; NB, normal breathing; IOP, intraocular pressure; SD, standard deviation.

Left Nostril Breathing Group

In LNB group, there was no significant change in the right eye IOP after the breathing exercise (Table 2), where as in the left eye, there was a significant reduction from 14.2 ± 2.7 mmHg to 13.3 ± 2.5 mmHg ($p < 0.0001$). Both eyes combined, there was a reduction in IOP of 0.6 ± 1.4 mmHg ($p < 0.0001$ with Wilcoxon signed rank test). Out of 41 subjects in LNB, in 33 (80.5%) subjects the IOP in the right eye either reduced or remained unchanged. In the left eye, in 36 (88%) subjects the IOP either reduced or remained unchanged.

Alternate Nostril Breathing and Normal Breathing Groups

In ANB, there was no significant change in the IOP in either eye after the breathing exercise (Table 2). Similarly in NB, there was no significant change in IOP after five minutes of normal breathing, in either eye.

Pulse and Blood Pressure

In the LNB and NB groups, there was statistically significant reduction in the pulse rate (Table 3). There were no cases with onset of bradycardia or tachycardia following the breathing exercise, nor was there any sudden rise or drop in blood pressure. No patients complained of any discomfort during or after the breathing exercise.

Table 2 The Mean Intraocular Pressures Before and After the Breathing Exercise in Each of the Study Groups

Group	Eye	Mean IOP Before (mmHg \pm SD)	Mean IOP After (mmHg \pm SD)	Z value	P value
Right nostril breathing	Right eye	14.3 \pm 3	13.9 \pm 2.6	-2.284	0.022 ^a
	Left eye	14.7 \pm 3.2	14.2 \pm 3.0	-2.406	0.016 ^a
Left nostril breathing	Right eye	13.9 \pm 2.9	13.6 \pm 2.9	-1.275	0.202
	Left eye	14.2 \pm 2.7	13.3 \pm 2.5	-4.148	< 0.0001 ^b
Alternate nostril breathing	Right eye	14.0 \pm 2.6	14.2 \pm 2.8	-0.835	0.404
	Left eye	14.1 \pm 2.6	14.1 \pm 2.9	-0.104	0.917
Normal breathing	Right eye	14.4 \pm 2.9	14.2 \pm 2.9	-1.429	0.153
	Left eye	14.1 \pm 3.2	14.1 \pm 2.9	-0.369	0.712

Notes: ^aStatistically significant at $p < 0.05$, ^bhighly significant at $p < 0.01$.

Abbreviations: IOP, intraocular pressure; SD, standard deviation.

Table 3 Pulse, Systolic Blood Pressure, and Diastolic Blood Pressure Before and After the Breathing Exercise

Group		Before (Mean \pm SD)	After (Mean \pm SD)	Z value	P value
Right nostril breathing	Pulse	70.9 \pm 9.4	71 \pm 9.4	-0.708	0.479
	SBP	123.4 \pm 12.8	122.6 \pm 13.5	-1.559	0.119
	DBP	76.6 \pm 8.6	75.4 \pm 8.6	-1.857	0.063
Left nostril breathing	Pulse	73.7 \pm 9.6	72.6 \pm 8.8	-2.261	0.024 ^a
	SBP	123.7 \pm 18.8	122.4 \pm 20.8	-0.943	0.346
	DBP	79.2 \pm 11.3	77.7 \pm 10.8	-1.864	0.062
Alternate nostril breathing	Pulse	74.2 \pm 10.3	73.3 \pm 10.4	-1.337	0.181
	SBP	118.8 \pm 21.1	120.5 \pm 12.9	-0.048	0.962
	DBP	75.9 \pm 7.5	75.8 \pm 7.8	-0.058	0.954
Normal breathing	Pulse	74.6 \pm 10.7	73.8 \pm 10.1	-2.104	0.035 ^a
	SBP	125.3 \pm 14.6	125.2 \pm 14.6	-0.222	0.824
	DBP	76.1 \pm 8.7	75.7 \pm 8.6	-1.313	0.189

Notes: Pulse was measured in beats per minute and blood pressure was measured in mmHg. ^aSignificant at $p < 0.05$ using Wilcoxon signed rank test.
Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; SD, standard deviation.

Discussion

In this study, we report the effects of different breathing techniques on the intraocular pressure. Right nostril breathing, left nostril breathing, and alternate nostril breathing are types of “Pranayama” and their effect was evaluated in comparison with normal breathing in healthy individuals. We found that individual nostril breathing, either right or left, did not increase the IOP but did bring about a significant decrease.

We recruited normal, ie, non-glaucomatous individuals in this study as a phase one trial, so as to establish the safety of the breathing exercises prior to proceeding with glaucoma patients. We concentrated on a specific aspect of yoga concerning regulation of breathing and the effect it had on IOP. The yogic art of regulation of breathing is called “Pranayama”.¹⁷ Right nostril breathing is called “Surya nadi pranayama”, left nostril breathing is known as “Chandra nadi pranayama” and alternate nostril breathing is “Anuloma viloma pranayama”.¹⁶ The “Kumbaka” variation of Anuloma viloma/ANB which entails holding the breath between inhalation and exhalation was not practiced in our study.

In our study, it was seen that both RNB and LNB had a higher proportion of eyes with reduction of IOP, whereas alternate nostril breathing or normal breathing did not show any significant change of IOP. Previous literature has shown that right nostril related breathing has sympathomimetic properties whereas left nostril breathing techniques has parasympathetic dominance.^{16,18} In the eye, both sympathetic and parasympathetic drugs are known to reduce IOP. This is an indication that, by stimulating either the sympathetic pathway or the parasympathetic pathway, by utilizing the appropriate Pranayama technique, we can potentially lower the IOP. Meditation, yoga and Pranayama have been shown to have an effect on nitric oxide in the body.^{19–21} Nitric oxide also has an IOP lowering effect by increasing the outflow of aqueous at the trabecular meshwork.^{22,23}

The average reduction in IOP in the RNB group was 0.5 ± 1.2 mmHg and in the LNB group was 0.6 ± 1.4 mmHg. This was statistically significant, but was lower than in previously reported studies.^{11,18} It has to be noted that in our study, the IOP was rechecked after a single session of breathing exercise. Even though it is a small reduction in IOP, it has been determined in the past that even a drop of one mmHg of pressure can reduce the chance of glaucoma progression by 10%.^{24,25} Further study is needed to determine whether similar reduction of IOP would be seen in patients with glaucoma.

In the ANB group, the mean IOP increased from 14.0 mmHg to 14.2 mmHg in the right eyes, this was not statistically significant. This is similar to the finding reported by Paidimarri who found no short-term effect of alternate nostril breathing

on IOP.¹⁰ It is important to note that none of the other groups had a mean increase in IOP following the breathing exercise. Special attention has to be paid to not hold the breath (Kumbhaka) during the exercise as it might lead to a rise in IOP.

Bhavanani et al, in analyzing the effects of different techniques of nasal breathing, found that LNB techniques tended to lower heart rate and blood pressure-related parameters whereas RNB techniques increased them.¹⁶ We found that the heart rate/pulse dropped significantly in the LNB group as well as the NB group, even though it was within the normal physiologic range. There were no significant changes in the blood pressure parameters in any of the groups.

Yoga is practiced by many individuals either for health reasons or as part of their lifestyle. One of the frequent questions encountered in ophthalmology, in the context of glaucoma is whether they can continue to practice yoga. Previous reports have determined that certain yogic postures like “shirsana” or head-stand can have a deleterious effect on glaucoma.^{26–29}

In the recent past there have been two studies on yogic breathing exercises and intraocular pressure. Paidimarrri et al studied the effect of Anulom-vilom alternate nostril breathing and their findings were similar to the findings in one of the groups in our study, the alternate nostril breathing group.¹⁰ In the study by Udenia et al,¹¹ the effect of diaphragmatic breathing and anuloma viloma pranayama was investigated and it was found to have a significant lowering effect on IOP. Along with anuloma viloma, we also studied the effect of right nostril breathing and left nostril breathing exercises. These are additional Pranayamas in practice and their effect on IOP has not been reported in the recent past.

Studies by Backon et al, Koçer et al, and Chen et al reported IOP lowering effects of “forced” right unilateral nostril breathing.^{18,30,31} The effect of left forced unilateral breathing was variable. In contrast to these studies, the breathing exercise advised by us was without force. Mohan et al evaluated the effect of unilateral as well as forced unilateral nostril breathing in young healthy individuals and found that right nostril breathing significantly reduced IOP, but not left nostril breathing.¹² The intervention groups were divided based on the nasal cycle. Our study differs from this as we included a wider age range of participants who were randomized into intervention groups, and we found that both right and left nostril breathing lowered IOP.

The strength of our study is that we sought to determine the effects on IOP of specific, individual Pranayama techniques and not a combination of breathing techniques which is also termed Pranayama. We established that these specific yogic breathing exercises do not adversely affect IOP in normal individuals. We found that unilateral breathing which is not forced, can also bring down the IOP and it need not be dependent on the phase of the nasal cycle. To the best of our knowledge, this has not been reported previously.

A limitation of our study is that we evaluated the IOP after only a single episode of breathing exercise. The long-term effects on IOP and also the frequency of practicing the breathing techniques to effectively lower IOP need to be assessed in future studies. Further research is required to determine the effect of these Pranayamas on glaucoma patients. Additional efforts are needed to evaluate the effect of Pranayama on the progression of glaucoma either as an addition to medical management or as stand-alone treatment. The same examiner measured the IOP before and after the exercise to avoid inter-observer variability,¹⁰ but this could have been a source of bias. Mask usage during IOP measurement can sometimes affect the readings and could have been a confounder, but extra care was taken in our study to avoid contact between the tonometer and mask.^{32,33}

Conclusion

With this study, we were able to determine that specific pranayama techniques like right and left nostril breathing, alternate nostril breathing were safe and had no adverse effect of raising IOP in normal subjects. Additionally, right and left nostril breathing techniques may have a beneficial effect of lowering IOP.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethical Statement

This research was reviewed and approved by the institutional review board of Kasturba Medical College Manipal, Manipal Academy of Higher Education (registration number ECR/146/Inst/KA/2013/RR-19). Informed consent was

obtained from all participants. The trial was registered prospectively with Clinical Trials Registry - India (registration number: CTRI/2020/02/023098, Registration date: 03/02/2020).

Acknowledgments

The authors would like to thank the nurses and technicians of Department of Ophthalmology, Kasturba medical college and hospital, Manipal for general support and translations.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Sadhasivam S, Alankar S, Maturi R, et al. Isha yoga practices and participation in samyama program are associated with reduced hba1c and systemic inflammation, improved lipid profile, and short-term and sustained improvement in mental health: a prospective observational study of meditators. *Front Psychol.* 2021;12:1–14. doi:10.3389/fpsyg.2021.659667
2. Swathi PS, Raghavendra BR, Saoji AA. Health and therapeutic benefits of Shatkarma: a narrative review of scientific studies. *J Ayurveda Integr Med.* 2021;12:206–212. doi:10.1016/j.jaim.2020.11.008
3. Moreno-Montañés J, Antón-López A, Duch-Tuesta S, et al. Lifestyles guide and glaucoma (I). Sports and activities. *Arch Soc Esp Oftalmol.* 2018;93:69–75. doi:10.1016/j.oftal.2017.09.005
4. Wylegala A. The effects of physical exercises on ocular physiology: a review. *J Glaucoma.* 2016;25:e843–e849. doi:10.1097/IJG.0000000000000454
5. Hecht I, Achiron A, Man V, Burgansky-Eliash Z. Modifiable factors in the management of glaucoma: a systematic review of current evidence. *Graefes Arch Clin Exp Ophthalmol.* 2017;255:789–796. doi:10.1007/s00417-016-3518-4
6. Jasien JV, Jonas JB, de Moraes CG, Ritch R. Intraocular pressure rise in subjects with and without glaucoma during four common yoga positions. *PLoS One.* 2015;10:e0144505. doi:10.1371/journal.pone.0144505
7. Sankalp DT, Yadav RK, Sharma HB, Netam RK, Kochhar KP. Effect of tratak (yogic ocular exercises) on intraocular pressure in glaucoma: an RCT. *Int J Yoga.* 2022;15:59–69. doi:10.4103/ijoy.ijoy_160_21
8. Balamurugan A, Srikanth K. A rare case of branch retinal vein occlusion following Sirsasana. *Int J Yoga.* 2016;9(2):173–175. doi:10.4103/0973-6131.183715
9. Mammo D, Page MA, Olson JH. Yoga-induced uveitis glaucoma hyphema syndrome. *Digit J Ophthalmol.* 2021;26:46–48. doi:10.5693/djo.02.2020.11.001
10. Paidimarri S, Bhardwaj R, Pathak-Ray V. Can breathing exercise or pranayama affect the intraocular pressure in the short-term? *J Glaucoma.* 2021;30:e18–e20. doi:10.1097/IJG.0000000000001682
11. Udenia H, Mittal S, Agrawal A, Singh A, Singh A, Mittal SK. Yogic pranayama and diaphragmatic breathing: adjunct therapy for intraocular pressure in patients with primary open-angle glaucoma: a randomized controlled trial. *J Glaucoma.* 2021;30:115–123. doi:10.1097/IJG.0000000000001697
12. Mohan SM, Reddy SC, Wei LY. Modulation of intraocular pressure by unilateral and forced unilateral nostril breathing in young healthy human subjects. *Int Ophthalmol.* 2001;24:305–311. doi:10.1023/B:INTE.0000006764.65209.06
13. Ismail AMA, Abd Elfatah Abo Saif HF, El-Moatasem Mohamed AM. Effect of Jyoti-Trataka on intraocular pressure, autonomic control, and blood glucose in diabetic patients with high-tension primary open-angle glaucoma: a randomized-controlled trial. *J Complement Integr Med.* 2021;1. doi:10.1515/jcim-2021-0041
14. Gillmann K, Weinreb RN, Mansouri K. The effect of daily life activities on intraocular pressure related variations in open-angle glaucoma. *Sci Rep.* 2021;11:1–7. doi:10.1038/s41598-021-85980-2
15. Singh K, Bhargav H, Srinivasan T. Effect of uninostil yoga breathing on brain hemodynamics: a functional near-infrared spectroscopy study. *Int J Yoga.* 2016;9:12. doi:10.4103/0973-6131.171711
16. Bhavanani AB, Ramanathan M, Balaji R, Pushpa D. Differential effects of uninostil and alternate nostril pranayamas on cardiovascular parameters and reaction time. *Int J Yoga.* 2014;7:60–65. doi:10.4103/0973-6131.123489
17. Jayawardena R, Ranasinghe P, Ranawaka H, Gamage N, Dissanayake D, Misra A. Exploring the therapeutic benefits of pranayama (yogic breathing): a systematic review. *Int J Yoga.* 2020;13:99–110. doi:10.4103/ijoy.IJOY_37_19
18. Backon J, Matamoros N, Ramirez M, et al. A functional vagotomy induced by unilateral forced right nostril breathing decreases intraocular pressure in open and closed angle glaucoma. *Br J Ophthalmol.* 1990;74:607–609. doi:10.1136/bjo.74.10.607
19. Kemper KJ, Powell D, Helms CC, Kim-Shapiro DB. Loving-kindness meditation's effects on nitric oxide and perceived well-being: a pilot study in experienced and inexperienced meditators. *EXPLORE.* 2015;11:32–39. doi:10.1016/j.explore.2014.10.002
20. Abishek K, Bakshi S, Bhavanani A. The efficacy of yogic breathing exercise Bhramari pranayama in relieving symptoms of chronic rhinosinusitis. *Int J Yoga.* 2019;12:120. doi:10.4103/ijoy.IJOY_32_18

21. Lim S-A, Cheong K-J. Regular yoga practice improves antioxidant status, immune function, and stress hormone releases in young healthy people: a randomized, double-blind, controlled pilot study. *J Altern Complement Med.* 2015;21:530–538. doi:10.1089/acm.2014.0044
22. Fingeret M, Gaddie IB, Bloomenstein M. Latanoprostene bunod ophthalmic solution 0.024%: a new treatment option for open-angle glaucoma and ocular hypertension. *Clin Exp Optom.* 2019;102:541–550. doi:10.1111/cxo.12853
23. Mao YJ, Wu JB, Yang ZQ, Zhang YH, Huang ZJ. Nitric oxide donating anti-glaucoma drugs: advances and prospects. *Chin J Nat Med.* 2020;18:275–283. doi:10.1016/S1875-5364(20)30035-2
24. Leske MC, Heijl A, Hussein M, Bengtsson B, Hyman L, Komaroff E; Early Manifest Glaucoma Trial Group. Factors for glaucoma progression and the effect of treatment: the early manifest glaucoma trial. *Arch Ophthalmol.* 2003;121(1):48–56. doi:10.1001/archophth.121.1.48
25. Jayaram H. Intraocular pressure reduction in glaucoma: does every mmHg count? *Taiwan J Ophthalmol.* 2020;10:255. doi:10.4103/tjo.tjo_63_20
26. Baskaran M, Raman K, Ramani KK, Roy J, Vijaya L, Badrinath SS. Intraocular pressure changes and ocular biometry during Sirsasana (headstand posture) in yoga practitioners. *Ophthalmology.* 2006;113:1327–1332. doi:10.1016/j.ophtha.2006.02.063
27. Bertschinger DR, Mendrinis E, Dosso A. Yoga can be dangerous-glaucomatous visual field defect worsening due to postural yoga. *Br J Ophthalmol.* 2007;91:1413–1414. doi:10.1136/bjo.2007.114546
28. de Barros DS, Bazzaz S, Gheith ME, Siam GA, Moster MR. Progressive optic neuropathy in congenital glaucoma associated with the Sirsasana yoga posture. *Ophthalmic Surg Lasers Imaging.* 2008;39(4):339–340. doi:10.3928/15428877-20080701-03
29. Gallardo MJ, Aggarwal N, Cavanagh HD, Whitson JT. Progression of glaucoma associated with the Sirsasana (headstand) yoga posture. *Adv Ther.* 2006;23(6):921–925. doi:10.1007/BF02850214
30. Koçer I, Dane S, Demirel S, Demirel H, Köylü H. Unilateral nostril breathing in intraocular pressure of right-handed healthy subjects. *Percept Mot Skills.* 2002;95(2):491–496. doi:10.2466/pms.2002.95.2.491
31. Chen JC, Brown B, Schmid KL. Effect of unilateral forced nostril breathing on tonic accommodation and intraocular pressure. *Clin Auton Res.* 2004;14(6):396–400. doi:10.1007/s10286-004-0200-4
32. Quaranta L, Micheletti E, Riva I, Weinreb RN. Intraocular pressure measurement in patients wearing filtering facepiece masks. *J Glaucoma.* 2020;29(10):999–1000. doi:10.1097/IJG.0000000000001640
33. Davanian AM, Donahue SP, Mogil RS, Groth SL. Mask-induced artifact impacts intraocular pressure measurement using Goldmann applanation tonometry. *J Glaucoma.* 2021;30(3):e47–e49. doi:10.1097/IJG.0000000000001746

Clinical Ophthalmology

Dovepress

Publish your work in this journal

Clinical Ophthalmology is an international, peer-reviewed journal covering all subspecialties within ophthalmology. Key topics include: Optometry; Visual science; Pharmacology and drug therapy in eye diseases; Basic Sciences; Primary and Secondary eye care; Patient Safety and Quality of Care Improvements. This journal is indexed on PubMed Central and CAS, and is the official journal of The Society of Clinical Ophthalmology (SCO). The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/clinical-ophthalmology-journal>