Original Article

Effect of Tratak (Yogic Ocular Exercises) on Intraocular Pressure in Glaucoma: An RCT

Sankalp, Tanuj Dada[1], Raj Kumar Yadav, Hanjabam Barun Sharma, Ritesh Kumar Netam, Kanwal Preet Kochhar

Department of Physiology, All India Institute of Medical Sciences, [1]Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi, India

Abstract

Introduction: In healthy subjects, the intraocular pressure (IOP) is maintained by a dynamic equilibrium between continuous production of aqueous humor by ciliary bodies and continuous outflow through the two drainage pathways: trabecular meshwork and uveoscleral outflow. Here, we hypothesized that yogic ocular exercises, including extraocular muscles exercise, and modified *Tratak Kriya* (m*TK*), might reduce the IOP as well as stress and improve quality of life (QoL) in patients with glaucoma. **Methodology:** A parallel two-arm randomized controlled trial (RCT) was conducted in glaucoma patients (Control group and Intervention group). Control group patients were on standard medical treatment and intervention group patients practiced a Yoga-based lifestyle intervention (YBLI) for 4 weeks as add-on therapy with their standard medical treatment. All Participants were assessed at baseline day 1, day 14 (D14), and day 28 (D28). A minimum of 30 patients were recruited in each group. **Results:** We did not observe any statistically significant different mean IOP of right (IOP-r) or, left eyes at any time point as well as cortisol level and QoL between the two groups. However, with in intervention group, there was a reduction in IOP-r at D14 (15.54 ± 2.81 mmHg) and D28 (15.24 ± 3.1 mmHg), P = 0.006 and 0.001, respectively, compared to their baseline IOP (16.26 ± 2.98). **Conclusion:** Based on the present RCT, yoga-based ocular exercises practiced here cannot be recommended for management of raised IOP in glaucoma patients. Further larger studies are warranted with yoga-based interventions in patients with glaucoma. **Clinical Trial Registration Number** CTRI/2016/03/006703

Keywords: *Eye accommodation, glaucoma, intraocular pressures, ocular exercise, Tratak Kriya, yoga*

Introduction

Glaucoma is an ocular blinding disease. Raised intraocular pressure (IOP) is the most common contributor for the damage of retinal ganglionic cells and the optic nerve. The precise etiology of glaucoma is still debatable. Stress, diabetes, hypertension, obesity, and the raised IOP due to the overproduction and/or under drainage of aqueous humor (AH) are among significant risk factors for glaucoma.[1-5] Furthermore, a new evidence suggests that glaucoma could be an autoimmune disease with progressive retinal degeneration caused by T-cells.[6]

IOP, most readily amenable risk factor, in healthy individuals varies between 10 and 21 mmHg. It is maintained by a dynamic equilibrium between continuous production of AH by ciliary bodies and continuous outflow through the two drainage pathways: while Trabecular meshwork (TM) permits AH egression by vacuoles, pores, and transcytosis,[7] uveoscleral (US) outflow is possible due to the absence of epithelial layer on the ciliary muscles in the anterior chamber.[8] Outflow through both the TM and the US pathway is influenced by the activity of ciliary muscles.[9-17] AH outflow through TM decreases with ciliary muscle relaxation and increases with its contraction due to increased trabecular pore size.[18] Similar to TM, the state of ciliary muscle affects the US outflow but in the opposite manner, i.e., relaxation increases the outflow while contraction decreases it.

Treatment modalities of glaucoma aim to reduce or prevent an increase in IOP, the only alterable variable and mainstay of the treatment. Medications like prostaglandin analogs increases US outflow,[8] and parasympathomimetic agents like pilocarpine increases the TM outflow.[19]

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Address for correspondence:
Dr. Raj Kumar Yadav, Department of Physiology, All India Institute of Medical Sciences, New Delhi - 110 029, India.
E-mail: raj3kr@gmail.com

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The unavoidable stress of today's life and reduced Quality of Life (QoL) due to the existing standard medical treatment[20,21] encourages us to look for more affordable treatment modalities with fewer side-effects.

Yoga based lifestyle intervention (YBLI) is an effective nonpharmacological therapeutic approach in different diseases,[22-33] however, it has not been studied adequately in glaucoma. In last few decades, the testimony available from various research centers accorded the favorable outcome of YBLI on varying types of stress,[34,35] diabetes, hypertension, obesity, and QoL[36] in glaucoma.[22-33] Some of the handful studies concluded that yoga might be detrimental in glaucoma, most of the studies included certain body postures in their interventions, like inverted headstand, that are contraindicated in glaucoma.[37-43]

Our study hypothesis was that Yogic ocular exercises (YOE) including extraocular muscles exercise and *Tratak Kriya* (*TK*) might reduce the IOP as well as stress and improve the QoL in patients with glaucoma.

TK, often called as yogic visual concentration, is considered as one of the eye cleansing techniques that even enhances cognitive functions.[44,45] *TK* primarily involves prolonged fixation of gaze on a nearby objects or distant objects.[46]

To the best of our knowledge, no study was available to observe the effects of *TK* in patients with glaucoma at the time of conception of the study.

Therefore, the present study was planned to compare the effects of a short-term YBLI, including YOE and *TK*, as an adjunct to standard medical treatment on IOP, stress, and QoL in patients with glaucoma.

Methodology

The study was approved by the institute's ethics committee (IECPG-136/27.01.2016) as part of postgraduate research and it was registered with CTRI (CTRI/2016/03/006703). The participant informed consent form was read and signed by all the patients before any study related procedure was done.

Study design

A parallel two-arm randomized controlled trial (RCT).

Recruitment of subjects

A total of 38 patients in control group (standard Medical treatment) and 34 patients in intervention group (standard Medical treatment + Yoga) from Glaucoma Clinic, Dr. Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences (AIIMS), New Delhi, were recruited, as per our inclusion and exclusion criteria, between March 2016 and July 2017.

Inclusion criteria

Patients of either gender, aged 18–60 years with visual acuity of >6/60, on standard medical treatment for glaucoma were included in the study if their anti-glaucoma treatment did not change for the past 1 month, before the enrollment.

Exclusion criteria

Patients having acute angle-closure glaucoma or its history, severe ocular trauma, uncontrolled/untreated hyperthyroidism, hypertension, and diabetes were excluded from the study. Those who were unable or unwilling to perform the study intervention were not included in the study too.

Sample size

Since this study was done as a part of MD thesis, thus due to constraint of time no formal sample size was calculated. A minimum of 30 patients were planned to be recruited in each group.

Randomization

The recruited subjects were randomized into two groups: control group and intervention group using "blind envelope technique." Eighty envelopes were prepared, considering a minimum of 30 patients in each group, sealed, and then mixed (by an independent person not related to the study) and handed over to the investigator. Each study participant was asked to pick one envelope from a basket containing identical, opaque, sealed brown envelopes. Out of these 80 envelopes, 40 of those had tickets printed with letter "A" and the rest 40 envelopes had tickets printed with the letter "B."

Study intervention

During the study, both the groups continued their standard medical treatment. As add-on therapy, Intervention group participants were taught and trained a short-term YBLI for the first 2 weeks by a well-trained yoga therapist at Integral Health Clinic (IHC), Department of Physiology, AIIMS, New Delhi. Then, for the next 2 weeks, intervention group participants were advised to practice the same yoga-exercises at their homes preferably in an open space like roof or park as taught at IHC. Control group participants were also offered the YBLI once their 1 month of the study period ended (waiting period) in order to increase the compliance of the study.

Here, YBLI included YOE and modified-*TK* (m*Tk*) for a total of about 60 min per day, repeated in the same sequence during each session [Appendix I]. The intervention was performed by the participants in sitting posture on the floor. Some participants who had difficulty in sitting on the floor performed the yoga intervention while being seated on a chair.

YOE comprised eyeball movements (sequentially in all four directions and rotational movements), synchronized with breathing for about 15 min.

Our participants practiced *TK* in the same sitting posture with some modifications, synchronization with breathing. Hence, we termed it as *mTK*. Usually, *TK* is performed by continuously gazing either at a near object or a distant object. The *mTK* involved static and dynamic components, synchronized with breathing [Flowchart 2]. For static component, participants were asked to stare at a near object (thumb of one hand placed in front) for 5 s with inhalation and then stare at a distant point on the wall (at the level of eyes, 15 feet away from the participant) for 5 s with the exhalation, alternately. For dynamic component, participants had to fix their gaze at the tip of their thumb while it moved, toward and then away from the participant in the area between the two eyes. The thumb movement toward and away from the subject was performed for 5 s each (total of 10 s), along with inhalation and exhalation, respectively. The m*TK* was done for about 30 min per session.

During the interval between, the end of one exercise and the start of the next exercise, a yogic procedure named palming was performed along with deep inhalation and deep exhalation for relaxation. Palming consists of rubbing both the palms vigorously to make them warmer and then placing them on closed eyes. Palms are placed over eyes in such a way that the cup of palm lies over the closed eyes with minimal pressure and the adducted fingers of one palm superimposed over adducted fingers of other palm in the forehead region.

Every day, *OM* chanting and pranayama was included for about 10 min according to the predetermined schedule [Appendix 1].

During follow-up period at home (3rd and 4th week of study), regular telephonic conversation was done to encourage the participants for continuing the intervention every day.

Study assessments

Participants were assessed as per study protocol, in morning hours between 8:30 AM and 10 AM, to minimize diurnal variation in IOP, at 3-time points, i.e., day 1/ baseline (D1), day 14 (D14), and day 28 (D28), for the following parameters:

1. IOP of right eye (IOP-r) and left eye (IOP-l), measured by noncontact tonometry
2. QoL was assessed using the Glaucoma QoL − 15 questionnaire and World Health Organization QoL BREF questionnaire (BREF) in English or Hindi
3. The stress level was assessed by estimation of plasma cortisol and plasma endorphin levels by ELISA method
4. Fasting blood sugar was estimated by the semi-automated analyzer
5. Blood pressure (BP) and heart rate were measured by digital BP device
6. Body mass index was calculated using the height (m) and weight (kg).

Statistical analysis

Data were analyzed using IBM SPSS ver. 25.0 (IBM Corp., Armonk, NY, USA). Normality testing was done using Shapiro-Wilk and Kolmogorov-Smirnov. Normally distributed data were expressed as mean ± standard deviation and nonparametric were expressed as median and Q1 (first quartile) and Q3 (third quartile). The comparison of parameters between the two groups at different time points was done using unpaired *t*-test for normally distributed data and Mann–Whitney *U*-test for others. The comparison of selected parameters within the same group was done using repeated measure analysis of variance for normally distributed data, and Friedman test for others. Bonferroni test was applied as a *post hoc* test subsequently. Statistical significance was considered at $P < 0.05$. To reduce the possible bias arising due to missing data, in the Intention to Treat (ITT) analysis, the authors have replaced the missing data with the immediately previous value of the same subject instead of leaving blank, and analysis was done accordingly. Effect size was estimated using absolute value (without sign) of Cohen's d for the comparison of IOP parameters at D14 and D28 between the two groups [Table 4].

Results

Baseline characteristics of 38 patients in control group and 34 patients in intervention group are presented as per ITT analysis [Flowchart I].

Participants were comparable between the groups in terms of age, height, gender, level of education, type of glaucoma as well as diabetes and hypertension [Table 1a and b]. All the parameters were statistically similar at the baseline i.e D1 [Table 2].

Between the group comparison, at D14 [Table 3], all the parameters were statistically comparable, except systolic BP ($P = 0.006$*). At D28 [Table 4], no significant difference was observed between the two groups. However, the mean delta score was significantly different for IOP-r ($P = 0.0002$), IOP-l ($P = 0.040$), and avg BREF score ($P = 0.002$), i.e., the changes in IO*P* values from D1 to D28. Except for IOPr_delta change at D28, whose effect size was found to be medium to large, all other effect size were small. This reflected in the power too, which was 89.73% for this parameter only.

In addition, within group analysis, across the three time-points, i.e., D1, D14, and D28, [Table 5], we observed that in intervention group, there was a reduction in IOP-r at D14 (15.54 ± 2.81 mm Hg) and D28 (15.24 ± 3.1 mmHg), $P = 0.006$ and 0.001, respectively, as compared to the IOP at D1 (16.26 ± 2.98). The IOP reduction was 4.4%

Table 1a: Study patients characteristics

Parameters	Control group (*n*=38), *n* (%)	Intervention group (*n*=34), *n* (%)	*P**
Age (years)	45.50 (31.5-50)	47.50 (35.75-56)	0.106
Height (cm)	158.5 (148.4-167.6)	159.7 (152.5-168.9)	0.463
Male (%)	19 (50-50.0)	19 (55.9-50.0)	0.618
Female (%)	19 (50-55.9)	15 (44.1-44.1)	
Total (%)	38 (100-52.8)	34 (100-47.2)	
Level of education (%)			
Illiterate	2 (5.3-66.7)	1 (2.9-33.3)	0.69
Upto 12th class	14 (36.8-56)	11 (32.4-44.0)	
Graduate	17 (44.7-54.8)	14 (41.2-45.2)	
Postgraduate	5 (13.2-38.5)	8 (23.5-61.5)	
Total	38 (100-52.8)	34 (100.0-47.2)	

*Pearson's Chi-square test applied

Table 1b: Distribution of type of glaucoma, hypertensives, diabetes mellitus patients among the studied groups

Type of glaucoma	Control group (*n*=38), *n* (%)	Intervention group (*n*=34), *n* (%)	*P***
Open-angle	14 (36.8-51.9)	13 (38.2-48.1)	0.903
Angle-closure	24 (63.2-53.3)	21 (61.8-46.7)	
Total	38 (100-52.8)	34 (100-47)	
HTN among the studied groups (*n*=72)			
Non-HTN	33 (86.8-58.9)	23 (67.6-41.1)	0.05
HTN	5 (13.2-31.2)	11 (32.4-68.8)	
Total	38 (100-52.8)	34 (100-47.2)	
DM patients among the studied groups (*n*=72)			
Non-DM	35 (92.1-57.4)	26 (76.5-42.6)	0.066
DM	3 (7.9-27.3)	8 (23.5-72.7)	
Total	38 (100-52.8)	34 (100-47.2)	

**Fisher's exact test applied. HTN=Hypertensives, DM=Diabetes mellitus

Table 2: Comparison between control group and intervention group parameters at day 1 (day 1/baseline)

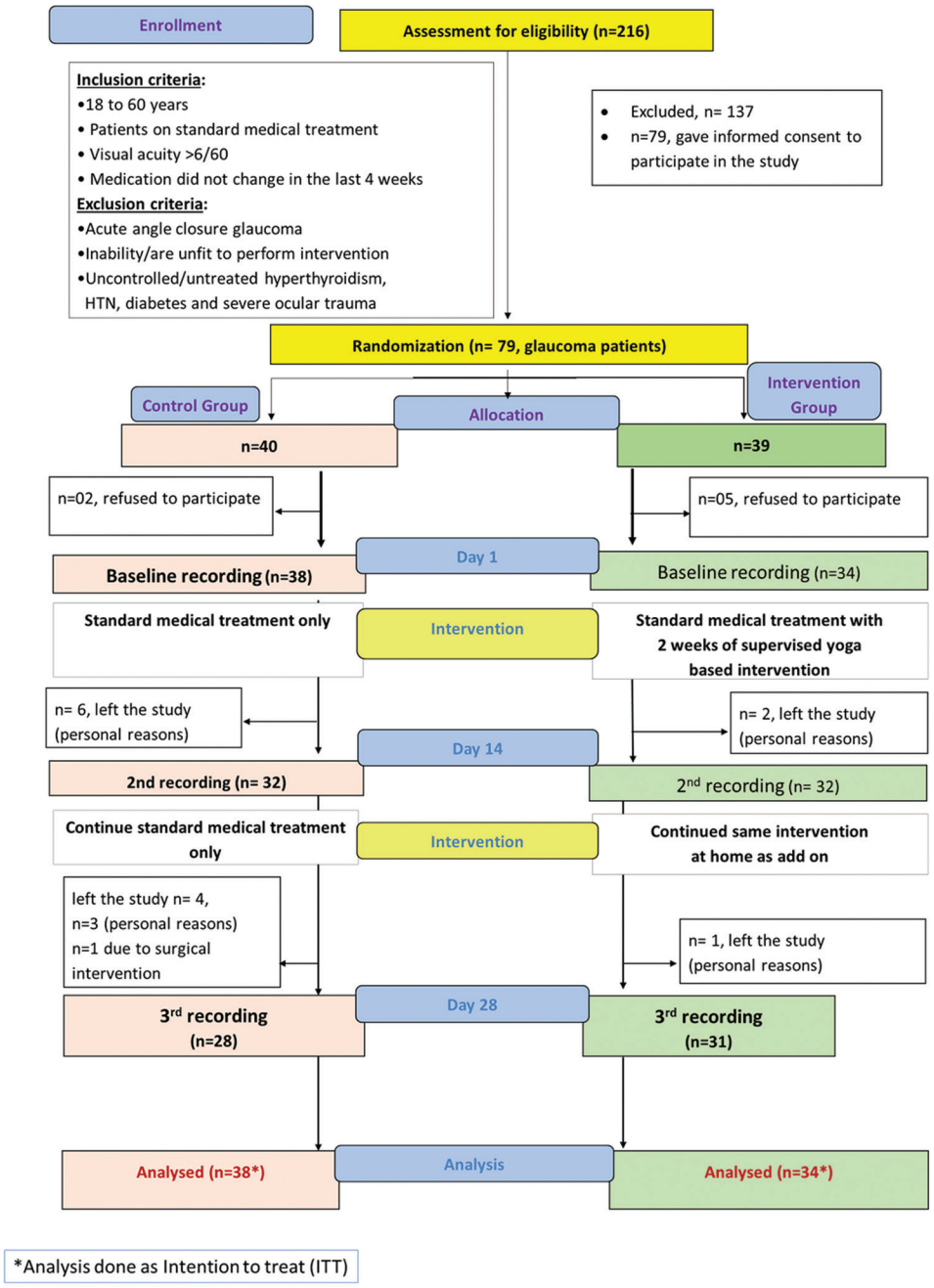
Parameters	Control group (*n*=38)	Intervention group (*n*=34)	*P*
IOP-r (mm hg)	16.45±3.86	16.26±2.98	0.819
IOP-l (mm hg)	16.09±3.58	15.95±3.16	0.865
GQL-15	27 (20–39)	33 (22-46.5)	0.269
Average BREF	64.33±15.03	60.82±12.12	0.391
Cortisol	254.8 (195.7-405.3)	277.9 (192.4-394.4)	0.994
Beta endorphin	117.8 (58.03-180.1)	213.5 (46.49-416.4)	0.172
HR (bpm)	75.32±12.1	76.5±11.49	0.672
SBP (mm hg)	122.9±12.66	128.3±14.81	0.099
DBP (mm hg)	80 (73.5-84.75)	81.5 (75.75-87)	0.462
FBG (mg/dl)	97.4 (87.36-106.3)	89.26 (81.22-113)	0.42
Weight (kg)	64.33±13.5	68.44±12.54	0.187
BMI (kg/sqm)	25.11 (22.91-27.07)	26.91 (23.24-29.16)	0.138

Unpaired *t*-test results are presented as mean±SD and Mann-Whitney *U*-test results are presented as median (Q1-Q3). SD=Standard deviation, IOP=Intraocular pressure, IOP-r=IOP of right, IOP-l=IOP of left, GQL-15=Glaucoma quality of life−15, HR=Heart rate, BP=Blood pressure, SBP=Systolic BP, DBP=Diastolic BP, BMI=Body mass index, FBG=Fasting plasma glucose, Q1=First quartile, Q3=Third quartile

and 6.2% in the right eye at D14 and D28, respectively, compare to Baseline IOP.

Discussion

In this randomized controlled trial, we did not observe any statistically significant different mean IOP of right or, left eyes at any time point between the two groups. The mean IOP between the two groups was similar at D14 and D28, but the "mean delta score" (calculated as pretreatment values minus posttreatment values) between control group and intervention group was significantly different for both the eyes at D28 [Table 4].



Flowchart 1: CONSORT flow chart of the study

In addition, we observed a higher Avg BREF score at D28 in intervention group patients. We did not observe any significant changes in cortisol and beta endorphin levels at any time point.

Dimitrova *et al* 2017[47] observed significantly reduced IOP immediately after YOE, done for 5 min in 12 healthy participants, versus 11 participants (control group). The authors described the mechanism of action of eye-rolling movement as complex and mentioned it as constant movement of eyes during the day and partly during the night usually involved small deviations from their primary position. During YOE, bulbomotor muscles are stretched in all directions that may lead to an increase in intra-orbital blood circulation as well as intra-orbital venous outflow. "Palming" might improve ocular outflow due to its vasodilator effect to episcleral veins."[47] However, in the current study, we did not observe any significant difference in mean IOP between the two groups.

Forced unilateral-nostril-breathing (*pranayama)* has been found to alter the IOP significantly in glaucoma patients.[48] A reduction in the IOP by 25% was witnessed with forced left nostril breathing, whereas forced right-nostril-breathing was found to increase the IOP by <5%.

Table 3: Comparison between control group and intervention group parameters at day 14

Parameters	Control group (*n*=38)	Intervention group (*n*=34)	*P* (Cohen's d effect size)
IOP-r (mm hg)	16 (13.3-17.85)	15.85 (13.93-17.4)	0.649
Δt1-t2	0 (−2.0-+0.50)	0 (−2.0-0)	0.677 (0.1406)
IOP-l (mm hg)	16.22±3.7	15.36±2.62	0.261
Δt1-t2	0 (−2.0-+1.0)	−1.00 (−2.0-0)	0.258 (0.2760)
GQL-15	28.5 (21-42.25)	29.5 (19-42.25)	0.898
Average BREF	61.33±13.77	61.51±12.64	0.963
Cortisol	297.9 (194.3-366.4)	225.7 (186.9-414.5)	0.872
Beta endorphin	136.5 (73.09-402)	178.1 (47.73-355.8)	0.956
HR (bpm)	78.08±12.85	77.59±10.33	0.859
SBP (mm hg)	120.9±11.76	130±15.59	0.006*
DBP (mm hg)	78.5 (66.5-84)	79 (74-85)	0.251
FBG (mg/dl)	96.27 (89.09-106)	94.84 (84.7-112.1)	0.538
Weight (kg)	60.4 (55.4-70.45)	67.85 (59.65-82.65)	0.091
BMI (kg/sqm)	25.12 (22.81-27.07)	27.03 (23.26-29.62)	0.123

**P* value found <0.05. Unpaired *t*-test results are presented as mean±SD and Mann-Whitney *U*-test results are presented as median (Q1-Q3). Δt represents gain score i.e., the change in the value in comparison to the baseline value at day 1. SD=Standard deviation, IOP=Intraocular pressure, IOP-r=IOP of right, IOP-l=IOP of left, GQL-15=Glaucoma quality of life-15, HR=Heart rate, BP=Blood pressure, SBP=Systolic BP, DBP=Diastolic BP, BMI=Body mass index, FBG=Fasting plasma glucose, Q1=First quartile, Q3=Third quartile

Table 4: Comparison between control group and intervention group parameters at day 28

Parameters	Control group (*n*=38)	Intervention group (*n*=34)	*P* (Cohen's d effect size)
IOP-r (mm hg)	16.3 (13.85-18.55)	15.15 (13-17.08)	0.114
Δt1-t3	0 (0-+1.0)	−1.0 (−2.0-0)	0.0002* (0.7961)
IOP-l (mm hg)	16.43±4.08	15.4±3.12	0.234
Δt1-t3	0.0 (−2.00-+1.0)	−0.50+2.15	0.040* (0.2158)
GQL-15	31 (19.75-40)	30 (22-41.5)	0.699
Average BREF	57.63 (51.13-69.75)	61 (58-75)	0.260
Cortisol	226.3 (190.9-372.2)	226.9 (182.3-358.6)	0.532
Beta endorphin	117.8 (73.71-307.4)	122 (158.87-355.8)	0.769
HR bpm	79.87±11.68	75.76±9.32	0.106
SBP (mm hg)	123.3±13.27	127.1±14.69	0.259
DBP (mm hg)	77.95±10.04	79.5±8.33	0.480
FBG (mg/dl)	97.04 (89.09-111.2)	92.90 (84.72-102.7)	0.118
Weight (kg)	64.22±13.42	68.22±12.36	0.194
BMI (kg/sqm)	25.13 (22.87-27.17)	26.92 (23.19-29.11)	0.170

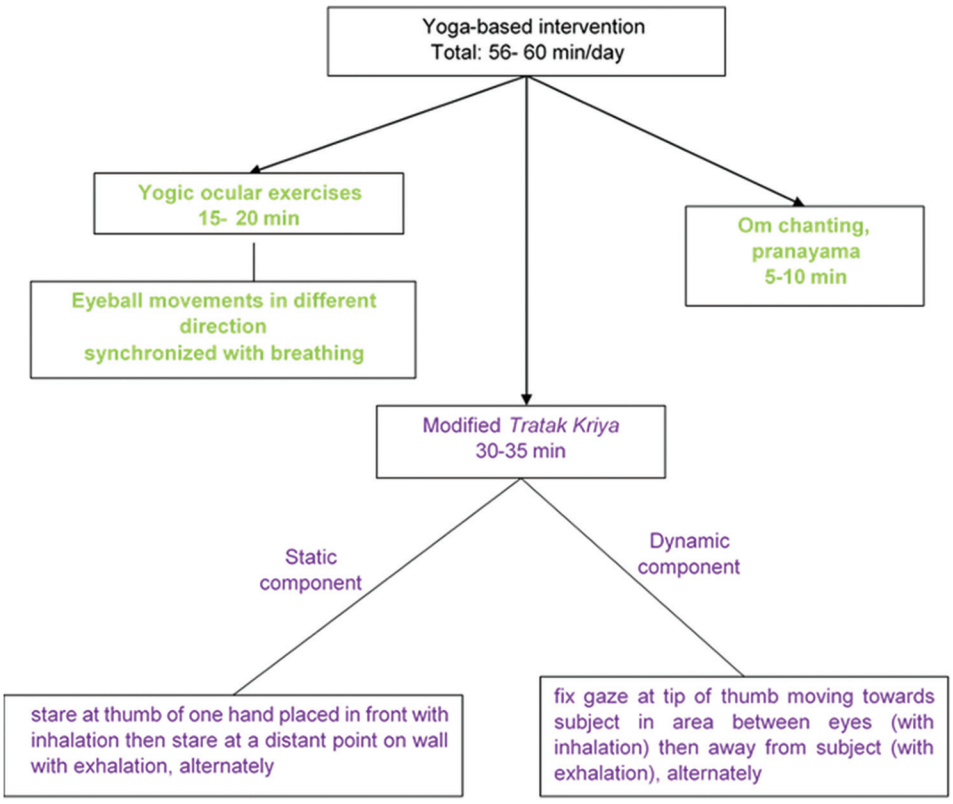
**P* value found <0.05. Unpaired *t*-test results are presented as mean±SD and Mann-Whitney *U* test results are presented as median (Q1-Q3). Δt represents gain score i.e., the change in the value in comparison to the baseline value at Day1. SD=Standard deviation, IOP=Intraocular pressure, IOP-r=IOP of right, IOP-l=IOP of left, GQL-15=Glaucoma quality of life-15, HR=Heart rate, BP=Blood pressure, SBP=Systolic BP, DBP=Diastolic BP, BMI=Body mass index, FBG=Fasting plasma glucose, Q1=First quartile, Q3=Third quartile

YOE, mentioned in ancient yoga literature as a practice involving eye rolling movements in different directions, has been found to decrease IOP. In a pilot study, Dimitrova and Trenceva assessed the effects of YOE along with palming on IOP and observed reduced IOP immediately postintervention.[47]

Dada et al. observed that mindful-meditation practice decreased IOP in glaucoma patients[49] in a RCT. However, in this study, the effects of accommodation exercises like *TK* were not studied.

TK has been suggested as a practice for maintaining ocular health and avoiding various eye diseases.[50] *TK* is a yogic practice involving accommodation and de-accommodation of eyes. It requires uninterrupted gazing of a nearby small object (like burning candle placed few feet apart) or a far-off big object like sun or moon, till watering of eyes begins. Recently, in 2019, *Gupta* and Aparna. found significant reduction of IOP in the healthy individuals who practiced YOE including *TK,* compared with the control group.[51]

There are some studies, which concluded that the accommodation of the eyes might reduce IOP. Armaly *et al.* observed that the accommodation of eyes significantly impacts the dynamics of IOP. Accommodation increases the outflow of AH as well as the inflow rate simultaneously and the IOP reduction depends on their relative magnitude.[52] Read SA *et al*. found that IOP dynamics



Flowchart 2: Yoga-based intervention offered to the participants

changes in myopes and it reduces with accommodation in emmetropes significantly.[53]

The observation of asymmetric impact in our study (significant reduction in right eye IOP and nonsignificant reduction in left eye IOP of Intervention group at different timepoints, *within group analysis*) could be because glaucoma generally affects bilaterally but does not always develop in both eyes at the same time, hence the severity might be asymmetric.[54,55] Also, the magnitude of response in the fellow eye might be different for the same intervention, akin to the asymmetric IOP fluctuation in response to a drug[56] and the physiological diurnal variation.[57,58]

A trend of increasing IOP and decreasing QoL score was observed in Control group [Table 5]. It could be due to the poor compliance of the patients to the drug schedule and doses as suggested by many other studies.[21,59,60]

Reason for the reduced IOP in intervention group (*within group analysis*) can be attributed to the mTK since it was performed for the majority of the duration. Although the specific mechanism underlying the positive effect is vague, with our present understanding, we can propose that the alternate accommodation and de-accommodation involved in mTK helps to increase the AH outflow from TM and US pathway during constriction and relaxation of ciliary muscles, respectively [Flowchart 3]. Furthermore, the IOP reduction in adjunctive therapy with anti-glaucoma medications may range from 7% to 37%.[61,62] Hence, the clinical significance of this intervention as an anti-glaucoma therapy is debatable since the IOP reduction (mean 1 mm Hg), although statistically significant, was around 6% only and good effect size was observed only in the right eye IOP at D28.

Strength of the study

To the best of our knowledge, this was the first study (at the time of conception) to assess the impact of YOE (eye-rolling movements) and *TK* (an accommodation based YOE) on the IOP in patients with glaucoma.

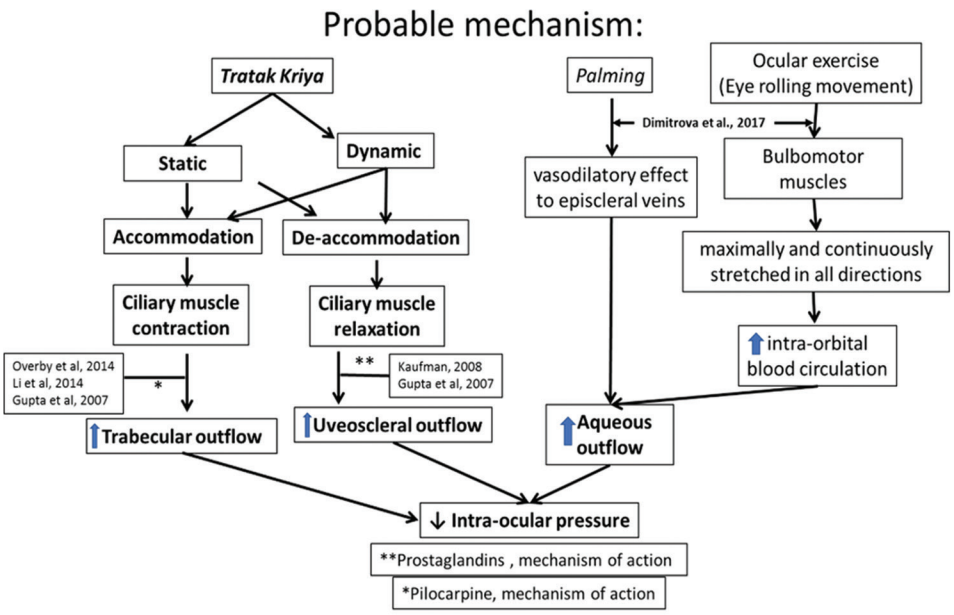
Limitations of our study

As this was a pilot study for m*TK*, here no formal sample size was calculated.

Furthermore, the individual contributions of YOE and TK cannot be evidently commented.

Conclusion

It may be implied that the short-term YBLI including ocular exercise and *mTK* might have some positive influence on the IOP dynamics in patients with glaucoma. Based on the results, yoga-based ocular exercises used in the present RCT cannot be recommended for the management of raised IOP in glaucoma patients. Multiple studies with



Flowchart 3: Probable mechanism

Table 5: Comparison of parameters across the time points

Parameters (A: Control group; B: Intervention group)	Baseline/Day 1	Day 14	Day 28	*P*
A. IOP-r (mm hg)	16 (13.95–18.65)	16 (13.3–17.85)	16.3 (13.85-18.55)	0.627
B. IOP-r (mm hg)	16.26±2.98	15.54±2.81#	15.24±3.1#	0.001*
A. IOP-l (mm hg)	16.08±3.57	16.22±3.69	16.43±4.08	0.733
B. IOP-l (mm hg)	15.95±3.1	15.36±2.6	15.4±3.1	0.114
A. GQL-15	27.00 (20-39)	28.50 (21-42.25)	31.00 (19.75-40)	0.547
B. GQL-15	32.00 (20.75-46.25)	29.50 (19-42.25)	29.00 (20.75-41.25)	0.786
A. Average BREF	64.25 (53-73.18)	61.25 (53.25-69.18)	57.62 (51.12-69.75)	0.009*
B. Average BREF	56.50 (53-72)	59.25 (51.75-72)	61.00 (58-75)	0.166
A. Cortisol	254.76 (195.76-405.37)	297.75 (194.37-366.35)	226.19 (190.92-372.16)	0.109
B. Cortisol	278.07 (192.3-394.25)	225.69 (186.91-414.34)	226.67 (182-31-358.75)	0.618
A. Beta endorphin	117.76 (58.02-180.13)	136.54 (73.09-401.98)	117.76 (73.71-307.4)	0.661
B. Beta endorphin	213.52 (46.49-416.44)	178.0 (47.7-355.8)	121.96 (58.86-355.81)	0.577
A. HR bpm	75.32±12.09	78.08±12.84	79.87±11.67	0.022*
B. HR bpm	76.50±11.49	77.59±10.033	75.76±9.32	0.519
A. SBP (mm hg)	122.89±12.66	120.92±11.75	123.34±13.27	0.229
B. SBP (mm hg)	128.29±14.8	129.97±15.58	127.09±14.69	0.145
A. DBP (mm hg)	79.29±8.85	76.11±10.17	77.95±10.04	0.255
B. DBP (mm hg)	80.53±7.48	79.15±7.47	79.5±8.33	0.535
A. FBG (mg/dl)	97.13 (87.35-106.32)	96.50 (89-106.04)	97.03 (89-111.23)	0.323
B. FBG (mg/dl)	89.25 (81.21-112.96)	95.05 (84.7-112.06)	92.98 (84.71-102.7)	0.278
A. Weight (kg)	60.65 (55.6-70.37)	60.40 (55.4-70.45)	60.25 (55.62-70.8)	0.963
B. Weight (kg)	67.45 (59.7-80.4)	67.85 (59.65-82.65)	66.95 (60.05-79.75)	0.399
A. BMI (kg/sqm)	25.0 (23.01-27.16)	25.0 (22.97-27.12)	25.00 (22.98-27.17)	0.880
B. BMI (kg/sqm)	27.06 (23.23-29.15)	27.03 (23.26-29.62)	26.98 (23.18-29.11)	0.279

*P value found <0.05. #Significantly different from the baseline value. Repeated measure ANOVA presented as mean±SD and Friedman test results are presented as median (Q1-Q3; Bonferroni *post hoc* test applied for B. IOP-r and A. Average BREF). SD=Standard deviation, IOP=Intraocular pressure, IOP-r=IOP of right, IOP-l=IOP of left, GQL-15=Glaucoma quality of life-15, HR=Heart rate, BP=Blood pressure, SBP=Systolic BP, DBP=Diastolic BP, BMI=Body mass index, FBG=Fasting plasma glucose, Q1=First quartile, Q3=Third quartile

larger sample size are needed to validate the influence of yoga-based interventions in patients with glaucoma.

Ethical clearance

The study was approved by the institute's ethics committee (IECPG-136/27.01.2016) as part of postgraduate research and it was registered with CTRI (CTRI/2016/03/006703).

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Conflicts of interest

There are no conflicts of interest.

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Appendix 1: Details of yoga-based ocular exercise practiced by the subjects

Name of exercise	Steps involved	Synchronization with breathing
Eye-ball movement	Toward right	With exhalation
	Toward center	With inhalation
	Toward left	With exhalation
Palming	Palm rubbing	
	Palm on eyes	
Eye-ball movement	Upward	With exhalation
	Toward centre	With inhalation
	Downward	With exhalation
Palming	Palm rubbing	
	Palm on eyes	
Eye-ball movement	Clockwise	Exhalation (during downward movement) + inhalation (during upward movement)
	Centre	
	Anti-clockwise	Exhalation (during downward movement) + inhalation (during upward movement)
Palming	Palm rubbing	
	Palm on eyes	
Accommodation exercise	Thumb in front of nose between the eyes	Inhalation with near point gaze Exhalation with distant point gaze
Palming	Palm rubbing	
	Palm on eyes	
Accommodation exercise	Thumbs on folded knees	Inhalation while gaze fixed on right thumb Exhalation while gaze fixed on distant point Inhalation while gaze fixed on left thumb
Palming	Palm rub	
	Palm on eyes	
Accommodation exercise	Gaze fixed on left thumb while it moves toward and away from the subject in front of nose between the eyes	Inhalation while thumb moves toward the subject Exhalation while thumb moves away from the subject
Palming	Palm rubbing	
	Palm on eyes	
Accommodation exercise	Gaze fixed on right thumb while it moves toward and away from the subject in front of nose between the eyes	Inhalation while thumb moves toward the subject Exhalation while thumb moves away from the subject
Palming	Palm rubbing	
	Palm on eyes	
Figure of eight	Vertical	Inhalation when going away from centre and exhalation when moving toward the centre
	Horizontal	
Palming	Palm rubbing	
	Palm on eyes	