Research article

Systemic and ocular pressure changes following sympathetic activation in yoga practitioners - A comparative study

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ABSTRACT

Introduction and Aim: Blood Pressure (BP), Intraocular Pressure (IOP) and Ocular Perfusion Pressure (OPP) are precursor parameters that lead to development of glaucoma. Under conditions of stress, either physical or psychological origin, there is disturbance of autonomic regulation. This causes increased activation of the sympathetic nervous system which might influence BP and ocular pressures. An altered autonomic balance towards lower sympathetic drive is observed in subjects practicing yoga, but it is not clear whether this adaptation also influences ocular pressures. Our study attempted to analyze variations in BP, IOP and OPP following sympathetic activation in yogic practitioners and non-practitioners of yoga.

Materials and Methods: One hundred and ten subjects aged 18 - 25 years were recruited and categorised into yoga and non-yoga group. Basal BP was recorded using a sphygmomanometer and IOP was recorded using a rebound tonometer. Isometric hand grip (IHG) and Cold pressor test (CPT) were administered one at a time. IOP and BP were recorded immediately following these sympathetic activation tests. Mean arterial pressure and OPP was calculated using standard formula.

Results: Significant increase in the values of pulse, BP, IOP and OPP following sympathetic activation were observed in the non-yoga group which was not noted in the yoga group. Elevation in systemic and ocular pressures following sympathetic activation was less in yoga practitioners. This adrenergic response was greater in the non-yoga group.

Conclusion: Regular yoga practice maintains adequate perfusion of ocular tissues by autoregulation. Hence yoga can be recommended as a complementary health approach for the autonomic nervous system imbalance.

Keywords: Blood pressure; intraocular pressure; ocular perfusion pressure; isometric hand grip; cold pressor test.

INTRODUCTION

Intraocular pressure (IOP) is the fluid pressure that measures the magnitude of the force exerted by aqueous humor on the inner surface of the eye. Ocular perfusion pressure (OPP) is a vital factor that determines ocular blood flow. Alteration in IOP and OPP are precursor parameters that lead to development of glaucoma (1). Glaucoma is the second leading cause of blindness in the world according to WHO, that can affect the quality of life of the patients (2). A direct relationship between IOP and glaucoma has been shown in few clinical trials. Elevated IOP is considered the most important risk factor for retinal ganglion cell death (3).

Under conditions of stress, either physical or psychological origin, there is disturbance of autonomic regulation causing more activation of the sympathetic nervous system which might influence blood pressure (BP) and ocular pressures. As the autonomic system is complex, no single autonomic function test precisely reflects its complete functions. Cold pressor test (CPT) and Isometric handgrip test (IHG) are some of the tests that activate mainly sympathetic outflow (4). Isometric handgrip exercise is characterized by increase in BP and heart rate. The cold pressor response is an indicator of sympathetic activity after cold stress, and it produces a pressor response (5), (i.e., arteriolar constriction, increased HR, increased cardiac contractility) leading to increase in BP thus affecting OPP. One of the most well-known tests for determining the integrity of autonomic function tests is CPT. Cardiovascular response induced by CPT may affect ocular blood flow and neuronal function (6).

Yoga-the journey to perfection, is a mind-body exercise that helps to achieve a relaxed state that is useful in managing stress and anxiety caused by excessive sympathetic stimulation (7). An altered autonomic balance towards lower sympathetic drive is observed in subjects practicing yoga. Decreased arterial tone and peripheral resistance following reduction of sympathetic over activity ensures adequate peripheral circulation to tissues (8). This might have an impact on vascular effects of optic nerve head thus influencing ocular blood flow. Disturbance in autonomic balance influences systemic and ocular pressures. If yoga training blunts the

sympathetic drive and facilitates parasympathetic predominance, autonomic integrity can be achieved thus reducing some of the risk factors leading to glaucoma. As the interactions between BP, IOP, OPP and autonomic regulation is complex and there is paucity of literature in understanding their composite effects, this study was performed to understand the effects of sympathetic activation on systemic and ocular pressures in regular yoga practitioners. The aim of this study was to analyze the BP, IOP and OPP changes following sympathetic activation (CPT and IHG) in yogic practitioners and non-practitioners of yoga.

METHODOLOGY

This cross-sectional study consisted of 110 subjects aged 18 - 25 years. The minimum sample size was calculated to be 55 in each group based on Jyotsana *et al.,(*5) at α level of 5% with the confidence interval of 95%. Group 1 included healthy adult yoga practitioners who performed yoga regularly for a minimum period of six months recruited from Government naturopathy and yoga medical college, Mysuru. Yoga practice was part of their curriculum and it included warming up and stretching exercises, 9 rounds of fast pace *suryanamaskar* followed by standing series of asanas that included *thadasana, parvathasana, trikonasana, padha- angushtasana*, sitting series of asanas like *padmasana, paschimottanasana, vajrasana, gomukhasana* and *baddakonasana,* supine and prone series of asanas included *pavanamukthasana, sethubandhanasana* along with *ashtangasana, makarasana, bhujangasana, dhanurasana* followed by *Shavasana*. These *yogasanas* were done under the supervision of the yoga teachers of the college. The above said set of asanas varied within norms daily for one hour time period. Group 2 included age and sex matched subjects who did not exercise actively or practiced yoga. Subjects with history of glaucoma, acute or chronic conjunctivitis, high refractive errors of the eyes, contact lens users, smoking and consumption of alcohol and any other systemic disorders were excluded from the study. Ethical clearance was obtained.

The protocol and procedure of the study was explained and informed written consent was obtained. All the subjects were asked to fill a proforma which included their yoga practice. Anthropometric measurements like height in cm and weight in Kg were recorded using a stadiometer and weighing scale respectively. Basal IOP and BP were recorded in sitting position using SW-500 rebound tonometer (Tianjin Suowei Electronic Technology Co., Ltd, Tianjin, China) and Sphygmomanometer respectively after a resting period of 15 mins for all the subjects. To minimize the bias of examiners and diurnal variations of IOP, all the readings were measured between 4pm to 6pm by the same person (9).

After the basal recordings, the following sympathetic function tests were administered to all the participants one at a time.

1. Isometric handgrip test (IHG): Each subject held the handgrip dynamometer (INCO lab, Patiala, India) in the dominant hand and pressed once with maximum effort. The maximum voluntary contraction (MVC) was noted, and the subject was asked to hold the grip at 40% MVC as long as he/she can sustain. Their BP and IOP were recorded immediately after IHG and repeated after 10 minutes to study the recovery pattern.
2. Cold pressor test (CPT): Participants were requested to place their non-dominant hand completely immersed for 1minute in cold water maintained at 4-6^{o}C and BP was measured from the other arm at the end of 1 min (5). Their BP and IOP were recorded immediately after CPT and repeated after 10 minutes.

OPP was calculated as follows:
Mean arterial pressure = Diastolic BP + (1/3)(Pulse pressure)
Where Pulse pressure = Systolic BP - Diastolic BP
Mean ocular perfusion pressure (MOPP) = (2/3) Mean arterial pressure – IOP (9).

Statistical analysis

Percentage, arithmetic mean and standard deviation were applied using SPSS version 22. Inferential statistical tests like paired t test for before and after sympathetic function tests and unpaired ‘t’ test for comparison between yoga practitioners and controls was used.

RESULTS

The difference in the demographic parameters like age and BMI was not significant between the yoga group and non-yoga group (Table 1). No statistical significant difference in IOP and OPP between right and left eye were observed (Table 2). Hence only the readings of the right eye were considered for further analysis (10). There was significant increase in BP and IOP following a sympathetic activation in the non-yoga group (Table 3). This change was not observed in the yoga group (Table 4).

Pulse, BP and ocular pressure values recorded immediately following sympathetic activation with CPT were noticeably less in the yoga group (Table 5). Similar results were observed in the yoga group following the IHG test as well (Table 6).

Table 1: Demographic parameters of the participants of the study

Parameters	**Age(years)**	**BMI(kg/m^2)**
Non-yoga group	21.40±1.21	21.64 ±3.87
Yoga group	20.89±1.37	20.74±3.06

Table 2: Comparison of mean values of ocular pressures between right eye and left eye

Group	Parameters	Right eye (Mean± SD)	Left eye (Mean± SD)	P value
Non-yoga	IOP (mmHg)	17.65±3.75	18.37±2.74	0.229
	OPP (mmHg)	40.47±7.44	39.74±6.68	0.576
Yoga	IOP (mmHg)	16.31±1.90	15.87±4.01	0.265
	OPP (mmHg)	37.19±5.95	37.62±5.8	0.699

*p value: <0.05=Significant IOP: intraocular pressure, OPP: ocular perfusion pressure

Table 3: Comparison of mean values of blood pressure and ocular pressures immediately following IHG and CPT in non-yoga group

Parameters (mm Hg)	Basal value (Mean± SD)	Post-IHG (Mean± SD)	P Value	Post-CPT (Mean± SD)	P Value
SBP	111.0±14.23	115.6±14.66	0.004*	115.73±14.75	0.004*
DBP	75.70±9.93	80.75±13.14	0.008*	81.04±11.08	<0.001*
IOP	17.65±3.75	20.24±4.07	<0.001*	19.82±4.60	0.007*
OPP	40.47±7.44	41.34±7.52	0.559	41.92 ±8.20	0.608

*p value: <0.05=Significant. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, IOP: intraocular pressure, OPP: ocular perfusion pressure

Table 4: Comparison of mean values of blood pressure and ocular pressures immediately following IHG and CPT in yoga group

Parameters (mm Hg)	Basal values (Mean± SD)	Post IHG (Mean± SD)	P value	Post CPT (Mean± SD)	P value
SBP	105.24±12.05	107.36±14.54	0.218	105.47±12.10	0.859
DBP	67.75±8.43	71.0±8.95	0.011*	67.91±8.22	0.887
IOP	16.31±1.90	16.82±2.22	0.191	16.24±1.83	0.810
OPP	37.19±5.95	38.60±6.82	0.130	37.38±6.13	0.800

*p value: <0.05=Significant. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, IOP: intraocular pressure, OPP: ocular perfusion pressure

Table 5: Comparison of mean values of pulse, blood pressure and ocular pressures immediately following CPT between both the groups

Parameters	Non-yoga Group (Mean± SD)	Yoga Group (Mean± SD)	P value
Pulse(bpm)	90.45±14.73	83.47±11.25	0.006*
SBP(mm Hg)	115.73±14.75	105.47±12.10	<0.001*
DBP(mm Hg)	81.04±11.08	67.91±8.22	<0.001*
MAP(mm Hg)	92.6±11.45	80.43±8.90	<0.001*
IOP(mm Hg)	19.82±4.60	16.24±1.83	<0.001*
OPP(mm Hg)	41.92 ±8.20	37.38±6.13	<0.001*

*p value: <0.05=Significant. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, IOP: intraocular pressure, OPP: ocular perfusion pressure

Table 6: Comparison of mean values of pulse, blood pressure and ocular pressures immediately following IHG between both the groups

Parameters	Non-yoga Group (Mean± SD)	Yoga Group (Mean± SD)	P value
Pulse(bpm)	90.85±14.18	85.38±12.4	0.034*
SBP(mm Hg)	115.6±14.66	107.36±14.54	0.004*
DBP(mm Hg)	80.75±13.14	71.0±8.95	<0.001*
MAP(mm Hg)	92.36±12.36	83.12±9.95	<0.001*
IOP(mm Hg)	20.24±4.07	16.82±2.22	<0.001*
OPP(mm Hg)	41.34±7.52	38.6±6.82	0.047*

*p value: <0.05=Significant. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, IOP: intraocular pressure, OPP: ocular perfusion pressure

DISCUSSION

The current study aimed to compare BP and ocular pressure changes following sympathetic activation between yoga practitioners and non-practitioners of yoga. Results of this study suggest that all the parameters (pulse, BP, IOP and OPP) reflecting the sympathetic activation following IHG and CPT were significantly less in the yoga practitioners when compared to the non-yoga group.

Isometric muscle contractions have been found to result in increase in arterial blood pressure in normal individuals (11). Diminished elevation of BP levels in the yoga group following IHG when compared to the non- yoga group was found in our results. This finding matched with an analysis done on the effects of yoga on the sympathetic nervous system (8). Similar results were observed following CPT in yoga practitioners by Rajak *et al.,* They noticed a reduction in the cardiovascular hyper-reactivity to cold pressor test as indicated by pulse and BP in subjects who practiced yoga for 6 months (12). Also, BP response to IHG and CPT was significantly less in Raja yoga practitioners when compared to controls (5).

Increase in pulse and BP following isometric exercise (IHG) was observed in the non-yoga group of our study which was also noted by Bakke *et al.,* in their study on healthy individuals (13). The cardiovascular response following IHG and CPT noted in them could be because of elevated levels of sympathetic adrenergic vasomotor tone. This elevated response was not seen in subjects who were trained in yoga. Decrease in BP in yoga groups might be attributed to modulation of autonomic activity with parasympathetic predominance. This suggests that regular yoga practice regulates autonomic hyperactivity by blunting the sympathetic drive and shifting the autonomic function towards parasympathetic control.

Parasympathetic and sympathetic innervations influence IOP by regulating both aqueous humor production and outflow. However, the mechanism by which the sympathetic nervous system influences IOP remains controversial. It was observed by Bakke *et al.,* that IOP levels were high following IHG in normal individuals. Another study also found that the IOP rose significantly by 18% to 35% during hand grip exercise and it was parallel with the change in BP(14). In contradiction with this, IOP was found to be decreased during the cold pressor (15). This variation in IOP following IHG and CPT was not observed in yoga groups. Yoga might refine neuroendocrine regulation of the ciliary body and production of aqueous humor thus reducing IOP.

Since maintenance of OPP is a complex regulation process involving BP and IOP, there could be an impact on OPP by variations in these parameters. Increase in the OPP values were not much pronounced in the yoga group of our study in comparison with controls. This indicates adequate perfusion of ocular tissues in yoga practitioners by efficient auto regulatory processes. This regulatory control might be due to metabolic and myogenic mechanisms in addition to influence from the autonomic nervous system (16). Further studies with techniques which can measure ocular blood flow like Doppler optical coherence tomography could be done to clearly understand this mechanism (1). Smaller sample size limits this study and can be performed on a large scale. This study can be carried out in older age groups as well.

CONCLUSION

Our study suggests that elevation in systemic and ocular pressures following sympathetic activation was significantly less in yogic practitioners. Hence yoga can be recommended as an adjuvant therapy and complementary health approach for the autonomic nervous system imbalance. It can also be used as a preventive measure to reduce the risk factors leading to glaucoma.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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