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Effect of Aerobic Exercise on Intraocular Pressure in Young Individuals

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Abstract: *Physiological and biochemical changes that occur normally during physical exercise are profound. Intraocular pressure varies throughout the day and night. Henceforth, the diurnal variation for normal eyes is between 3 mmHg and 6 mmHg and the variation tends to increase in glaucomatous eyes. This study was conducted on 40 subjects at Punjabi University, Patiala between 3pm to 6pm. IOP was measured before and after exercise in 40 subjects (20 male, 20 female) with no ocular abnormality or any other systemic abnormality on subjects of age ranging from 17-24 years by using Schiotz tonometer. Weight, height, blood pressure and body mass index was calculated. The results obtained were compared between before and after exercise of subjects. Data is presented as the mean and standard deviation . Student t-test was used to calculate significance between mean. The IOP showed a statistically significant fall following aerobic exercise exercise. Mean IOP significantly decreased ($p<0.001$), immediately and after 15, 30 minutes ($p<0.001$) of aerobic exercise when compared to IOP recorded before exercise. Gender wise also showed difference in p value immediately after exercise. So the present study indicates the association of aerobic exercise with IOP.*

Keywords: *Intraocular pressure, aerobic exercise, schiotz tonometer.*

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I. Introduction

Maintenance of an ideal intraocular pressure is essential for proper visual functioning of the eye. Intraocular pressure is the fluid pressure inside the eyeball. Impairment of this pressure leads to series of visual defects.[1] The important physiological processes necessary for the functioning of the eye relate to the blood ocular barrier formation and circulation of intraocular fluid, maintenance of intraocular pressure and metabolism of the different ocular tissues.[2] Normal Intraocular pressure lies between 10 mmHg and 20 mmHg. Diurnal variation of IOP is between 3-6 mmHg.[3] Virtually all tissues and systems of human body respond to exercise programmes and the eye is no exception[4]. Many studies have shown important details concerning the Cardiovascular and Pulmonary physiological changes that are attributable to regular physical exercise regimen. But not many studies are available on the effects of exercise on the ocular physiological changes like intraocular pressure (IOP).[5] Exercise has been demonstrated to lead to changes in a range of ocular parameters. Previous studies have shown a reduction in IOP following different types and intensities of exercise , and it has been suggested that all forms of physical exercise such as bicycling, walking and jogging, decrease IOP.[6]

In normal subjects , Intraocular pressure decreases during exercise and its effects is inversely proportional to the work load. The degree of IOP reduction varies from in relation to the intensity and duration of the exercise, timing of the IOP measurement, diurnal variation and base line IOP. Increase in plasma osmolarity , blood lactate levels and decrease in blood pH have been associated with decrease in IOP.[7,8] The mechanisms of reducing the IOP by exercise is also believed to be associated with the lower concentration of norepinephrine, the rising of colloid osmotic pressure, the co-action of nitric oxide and endothelin after exercise, and also related to the gene polymorphism of β2-adrenergic receptor.[9,10]

II. Materials And Methods

The effect of aerobic exercise on intraocular pressure was evaluated on 40 candidates in the study (20 males and 20 females) ranging from 17-24 years of age. Individuals below 17 and above 24 , with any history of refractive errors, glaucoma, use of ocular medications, history of diabetes, hypertension , thyroid were excluded from the study.All the subjects gave informed written consent before the start and instructions pertaining to study were given in detail and explained to the subjects.Before the start of the study , Height, Weight and Blood pressure were recorded and then the subjects were told to lie down in supine position on couch. Paracaine eye drops were instilled in both eyes. After 2 minutes , the intraocular pressure was recorded in both eyes separately using Schiotz tonometer. All measurements were made with the Schiotz tonometer by the same examiner in the

same sitting , first in the right eye and then the left eye. The subjects were subjected to running for 1km per 5 minutes for 30 minutes. The first reading of IOP was taken immediately after exercise , second after 15 minutes, third after 30 minutes and fourth after 60 minutes of performance of exercise using Schiotz tonometer in both the eyes.

III. Statistical Analysis

The statistical analysis was done using unpaired t test and was expressed in terms of mean and standard deviation. p value was calculated.

IV. Results

The age group range was from 17 to 24 years of age with mean age of 20±2.11 years. The height in the study group ranged from 160 cm to 175 cm with mean height of 167.04 ±6.06 cm, the weight in the study group ranged from 50 kg to 75 kg with mean weight of 55± 7.94 kg.Each subject completed 30 minutes of exercise. Intraocular pressure decreased after exercise in both the eyes. There was no statistical difference in the IOP of right and left eye. (table 5) IOP in the right eye recorded before exercise was 15.37±1.03 mm Hg. The mean IOP measured immediately after exercise was 9.16±0.88 mm Hg, after 15 minutes mean IOP was 11.00±0.95 mmHg, after 30 minutes 12.62±0.98 mmHg and after 60 minutes was 13.90±0.99 mm Hg. The mean IOP significantly decreased ($p<0.001$) immediately,15 minutes, 30 minutes and 60 minutes of aerobic exercise when compared to IOP recorded before exercise (table 1). When IOP was compared before and after the exercise, it was observed that there was reduction in IOP immediately, 15 minutes, 30 minutes and 60 minutes after exercise with mean difference of 6.21±0.96 mmHg, 4.37±1.01 mm Hg, 2.75±0.96 mm Hg,1.40±0.76 respectively. This reduction was statistically significant ($p<0.001$) (table 2).

Table 1: Mean IOP of Right eye at Baseline and after exercise

Timing of IOP recording	Median	Mean ± SD (mm Hg)	p value	Significance
Baseline	15.25	15.37±**1.03**		
Immediately after exercise	9.40	9.16±**0.88**	<0.001	HS
15 minutes after exercise	11.20	11.00±**0.95**	<0.001	HS
30 minutes after exercise	12.20	12.62±**0.98**	<0.001	HS
60 minutes after exercise	13.40	13.90±**0.99**	<0.001	HS

Table 2: Mean difference of IOP of right eye before and after exercise

Timing of IOP recording	IOP (mm Hg)	Difference	SD	% difference	p value	Significance
Baseline	15.37					
Immediately after exercise	9.16	6.21	0.96	67.79	<0.001	HS
15 minutes after exercise	11.00	4.37	1.01	39.73	<0.001	HS
30 minutes after exercise	12.62	2.75	0.96	21.79	<0.001	HS
60 minutes after exercise	13.90	1.46	0.74	10.50	<0.001	HS

Table 3: Mean IOP of Left eye at Baseline and after exercise

Timing of IOP recording	Median	Mean ± SD (mm Hg)	p value	Significance
Baseline	15.25	15.30±1.02		
Immediately after exercise	9.40	9.17±0.86	<0.001	HS
15 minutes after exercise	11.20	11.02±0.93	<0.001	HS
30 minutes after exercise	12.20	12.62±0.95	<0.001	HS
60 minutes after exercise	13.40	13.90±0.99	<0.001	HS

Table 4: Gender wise comparison of intraocular pressure before and after exercise

Variables	Mean IOP (mmHg)					
	Right eye			Left eye		
	Males	**Females**	p value	**Males**	**females**	p value
Base line	15.73±1.00	15.01±0.95	0.043*	15.66±0.93	14.95±1.01	0.043*
Immediately after exercise	9.48±0.92	8.84±0.72	0.033*	9.48±0.92	8.87±0.68	0.040*
15 min after exercise	11.22±1.07	10.77±0.79	0.277	11.27±1.04	10.76±0.74	0.157
30 min after exercise	12.87±0.97	12.36±0.95	0.157	12.87±0.97	12.36±0.89	0.121
60 min after exercise	14.26±1.00	13.54±0.86	0.035*	14.26±1.00	13.54±0.86	0.035*
* significant ($p<0.05$)						

Table 5: Comparison of left and right eye before and after exercise

	Right eye	Left eye	p value	Significance
Timing of IOP recording	**Mean ± SD (mm Hg)**	**Mean ± SD (mm Hg)**		
Baseline	15.37±1.03	15.30±1.02	0.835	NS
Immediately after exercise	9.16±0.88	9.17±0.86	0.928	NS
15 minutes after exercise	11.00±0.95	11.02±0.93	0.931	NS
30 minutes after exercise	12.62±0.98	12.62±0.95	0.912	NS
60 minutes after exercise	13.90±0.99	13.90±0.99	1.00	NS

As the above table shows there was no statistical difference between right and left eye in case of IOP reduction.

V. Discussion

The fall in IOP after exercise has been subject to various investigations. In the present study it was found that in all subjects IOP has reduced after completion of the required aerobic exercise, the maximum reduction being 67%.The mean decrease in intraocular pressure was 6.13 mmHg immediately after exercise and was highly significant ($p<0.001$). The pressure fall was still below baseline at 15 and 30 minutes (39% and 22% fall respectively) and was statistically significant($p<0.001$).Harris et al suggested that the reduction of IOP correlated with the increase in blood lactate but they did not find any correlation with the plasma osmolarity or the PCO2 .[11] A previous study by Kielar et al noted that blood lactate and pH changes correlated the effect of exercise on IOP with the normal epinephrine blood concentration.[12]

Qureshi et al concluded in different studies that physical fitness reduces IOP and causes significant attenuation in the IOP response to physical exercise. They proposed that it would seem reasonable not to discourage patients who have glaucoma from light exercise . [13, 14]Passo et al reported decrease of IOP (5.9± 0.6 mmHg) after maximal aerobic exercise and also noticed that the decrease and the baseline of IOP were lower after 4 months of training. It is known that physically trained individuals in general tend to have lower BP as well.[15]The present study suggests that the aerobic exercise causes significant decrease in IOP. These results are further consistent with other studies being done. In our study there was a fall in iop even at 60 minutes.

CONCLUSION

Aerobic exercise causes decrease in intraocular pressure in normal healthy young individuals.So whether this pressure reduction will sustain in the long run and will help patients who are diagnosed as glaucoma is subject to further research and evaluation.

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