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ORIGINAL ARTICLE

EFFECT OF AEROBIC EXERCISE OF MODERATE INTENSITY AND SHORT DURATION ON INTRAOCULAR PRESSURE IN YOUNG INDIVIDUALS

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ABSTRACT: Intra-ocular pressure (IOP) in normal individuals varies throughout the night and day. The diurnal variation for normal eyes is between 3 and 6mmHg and the variation may increase in glaucomatous eyes. Hence, the present effort is to investigate the effect of moderate exercise on intraocular pressure changes. IOP was measured before and after exercise in 100 subjects (50M, 50F) with no ocular abnormality with ages ranging from 18-21 years by using Schiotz tonometer. Weight, height and body mass index, were recorded. The results obtained were compared between before-and-after-exercise of the subjects. The data were presented as the mean ± SD, Student's t-test was used to calculate significance between means. The IOP showed a statistically significant fall following moderate exercise. The mean IOP significantly decreased ($p<0.0001$), immediately and after 15, 30 minutes ($p<0.001$) of aerobic exercise when compared to the IOP recorded before exercise. The mean IOP was not significantly ($p>0.05$) decreased after 60 minutes of aerobic exercise. Gender wise comparison of intraocular pressure both before and after exercise did not reveal much significance. Physical exercise, such as jogging, walking and bicycle riding, could be suggested as a complimentary therapy in addition to the pharmaceutical and surgical therapies available for glaucoma patients, even though the mechanism for lowering IOP is not clear enough.

KEYWORDS: Exercise, intraocular pressure, Schiotz Tonometer.

AIM: The aim of the present study is to determine the relationship between the aerobic exercise and IOP and to know whether a significant difference in IOP lowering effect exists between before and after aerobic exercise.

INTRODUCTION: The reduction of IOP after exercise has been the subject of various investigations.[1-4] In normal subjects, the intraocular pressure decreases during exercise,[5] and its effect is inversely proportional to the work load.[6]

The degree of IOP reduction varied from study to study in relation to the intensity and duration of the exercise,[4,7] timing of the IOP measurement,[4] diurnal variation[8] and base line IOP.[4,5] 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 were very complicated and 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.

Gradation of severity of exercise, as per Concise Medical Physiology [9] attributed to Christensen, is made on the basis of energy expenditure, power (in Watt) and pulse rate, as per the chart at table 1 below.

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Class of exercise	O_2 uptake (L/min)	Power (W)	Pulse rate(/min)
Maximal	>2.5	850 or more	>175
Very heavy	2 to2.5	700 to 850	150 to 175
Heavy	1.5 to 2	500 to 700	120 to 150
Moderate	1.0 to 1.5	350 to 500	100 to 120
Light	Up to 1.0	170 to 350	Above resting up to 100

Table 1: Christensen classification

Ethics: This study was approved by the local Ethics Committee of the college, Rangaraya Medical College, Kakinada. Oral informed consent was obtained from all the subjects.

MATERIAL AND METHODS: The effect of exercise on intraocular pressure was evaluated in the clinical laboratory on one hundred 1st Year Medical student volunteers, comprising of 50 men and 50 women, ranging in age between 18 and 21 years, served as the subjects. Individuals above 21 or below 18 years of age, with any history of smoking, refractive errors, glaucoma, use of ocular medications, hypertension, history of diabetes, thyroid disorders are excluded from the study.

Materials used in the study were Schiotz tonometer, Sphygmomanometer, Bicycle Ergometer, measuring tape, weighing scale and Paracaine eye drops.

All subjects gave informed consent before the start of the study. They were given preliminary instructions. The procedure was explained to the subjects. The subjects also underwent a preliminary ophthalmologic examination before participating in the study. The study was conducted between 02:00 PM and 04:00 PM in the Department of Physiology.

Before undertaking the study age, height, weight, blood hemoglobin concentration, Respiratory Rate (RR), Heart Rate (HR) and Blood Pressure (BP) were recorded in the resting period, and then the subjects were asked to lie down in supine position on couch. Paracaine eye drops were instilled in both the eyes.

After 2 minutes the intraocular pressure was recorded in both eyes separately using Schiotz tonometer so that anesthetic acts. To determine pre-exercise IOP, three successive right eye (RE) and left eye (LE) readings were taken at interval of one hour. Average of three readings was considered as the pre-exercise IOP for the respective eye. All measurements were made with the Schiotz tonometer by the same examiner in the same sitting, first on the right eye and then on the left eye. By this, the attempt was to exclude all the changes of IOP due to diurnal variation**s** and repeated measurements.

Then each subject exercised on a bicycle ergometer with 2 Kg load, 30 pedaling and 78 revolutions per minute for total ten minutes duration. Four IOP recordings were taken. The first immediately, the second after 15 min, the third after 30 min and the fourth after 60 minutes of performance of exercise respectively.

The exercise testing was performed in the normal room temperature with bright light. All the readings of the study group were taken in the after-noon hours between 2 and 4 pm to maintain constancy of testing and to prevent any diurnal variation in IOP, which could possibly affect the results. Intraocular Pressure was measured in the both eyes.

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RESULTS: The age of the study group ranged from 18 to 21years, with mean age of 18.74 ± 0.70. The height of study group ranged from 150 to 180 cms with a mean height of 162.17± 3.96 cms, the weight of the study group ranged from 43 to 78kgwith a mean weight of 54.91 ± 3.77 kgs.

Each subject completed 10 minutes of exercise on the bicycle ergometer with 2 kg load, 30 pedaling and 78 revolutions per minute. The degree of exertion was moderate. Exercise resulted in an immediate increase ($p < 0.005$) in systolic blood pressure and a decrease in diastolic blood pressure ($p < 0.01$). The systolic blood pressure returned to baseline levels by 15 minutes while the diastolic pressure remained depressed throughout the hour ($p < 0.025$). The heart rate increased significantly ($p < 0.001$) immediately after exercise and did not return to baseline levels until 60 minutes.

Intraocular Pressure: IOP decreased after exercise in both the eyes. There was no statistical difference in the IOP of right and left eyes. Hence analysis is done for the right eye only.

IOP in Right Eye: The mean IOP recorded before exercise was 16.39 ± 2.12mm Hg. The mean IOP measured immediately after exercise was 10.47 ± 1.18, after 15 min was 11.62 ± 1.32 mm Hg, after 30 minutes was 13.61± 2.28mm Hg and 60 min after exercise was16.31± 4.8 mm Hg (Table 1). The mean IOP significantly decreased ($p<0.0001$) immediately, 15 minutes and after 30 minutes of aerobic exercise when compared to the IOP recorded before exercise.

When IOP was compared between before and after exercise it was found that there was reduction in IOP immediately, 15 minutes and 30 after exercise with a mean difference of 5.89± 1.45 mm Hg, 4.78 ± 1.39 mm Hg and 2.91± 1.09 mm Hg respectively. This reduction was statistically significant. ($p>0.0001$) but 60 min after exercise the reduction in IOP was statistically not significant.

Gender wise comparison of intraocular pressure both before and after exercise did not reveal much significance.

Timing of IOP recording	Mean ± SD (mm Hg)	p value
Baseline	16.39 ± 2.12	
Immediately after exercise	10.47 ± 1.18	< 0.0001 *
15 minutes after exercise	11.62 ± 1.32	< 0.001 *
30 minutes after exercise	13.61 ± 2.28	< 0.001 *
60 minutes after exercise	16.31 ± 4.81	> 0.05 †
(†Not significant (p>0.05); Significant (p<0.05); * Highly significant (p<0.001))		

Table 2: Mean IOP at baseline and after exercise

Timing of IOP recording	IOP (mm HG)	Difference	SD	% difference	p value
Baseline	16.39				
Immediately after exercise	10.47	5.89	1.45	56.4	<0.05 *
15 minutes after exercise	11.62	4.78	1.39	41.36	<0.05 *
30 minutes after exercise	13.61	2.91	1.09	21.77	<0.05 *
60 minutes after exercise	16.31	0.5	0.68	3.23	>0.05 †
NS: † not significant (>0.05); S: * significant (<0.05)					

Table 3: Mean difference of IOPs before and after exercise

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Variable	Mean IOP (mmHg)			
	Males (n=50)		Females (n=50)	
	Right eye	Left eye	Right eye	Left eye
Base line	16.18 ± 1.95	16.06 ± 1.63	16.19 ± 1.98	16.18 ± 1.77
Immediately after exercise	10.60 ± 1.45	10.63 ± 1.31	10.35 ± 0.85	10.17 ± 0.79
15 min after exercise	11.71 ± 1.56	11.79 ± 1.43	11.46 ± 0.96	11.54 ± 1.21
30 min after exercise	13.49 ± 1.78	13.55 ± 1.66	13.41 ± 1.42	13.53 ± 1.40
60 min after exercise	15.60 ± 1.80	15.47 ± 1.63	16.13 ± 2.20	15.95 ± 1.85

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

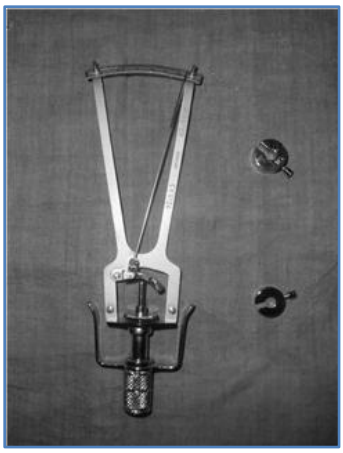

Fig. 1: Schiotz Tonometer

DISCUSSION: The reduction of IOP after exercise has been the subject of various investigations. [1-3] In the present study, it was observed that in all subjects there was an IOP reduction after aerobic exercise. The maximum fall in intraocular pressure occurred immediately following exercise (56%).

The mean fall in intraocular pressure (5.8 mm Hg) immediately after exercise and was highly significant ($p < 0.0001$). The intraocular pressure was still below baseline at 15 and 30 minutes (41%, 21% fall) and statically significant ($p < 0.001$). The IOP returned to almost pre-exercise levels by one hour.

The present study suggests that physical exercise causes significant attenuation in IOP. These results are consistent with other studies [1-3]. Numerous systemic physiologic changes that occur during exercise were proposed as possible mechanisms for this ocular hypotensive response. This might be due to a significant rise in blood lactate, a concomitant increase in plasma osmolarity, and a lowering of blood pH.

Martin et al demonstrated that acute dynamic exercise seems to alter IOP through changes in colloid osmotic pressure [10]. A relationship between increased plasma osmolarity and IOP reduction was also suggested by Ashkenazi et al. [2] However, Stewart et al noted that exercise induced greater changes in IOP than oral doses of glycerin for the same change in serum osmolarity. [11]

Also, Harris et al [12] 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 PCO_2. A previous study by Kielar et al [7] noted that blood lactate and pH changes correlated with intraocular tension changes at anaerobic exercise levels. Stewart et al also correlated the effect of exercise on IOP with the nor-epinephrine blood concentration. [11]

Orgul and Flammer reported that moderate exercise (6 deep knee bents) with a few seconds of duration can reduce IOP. [13] They correlated this reduction with changes in the heart rate and concluded that IOP reduction was the result of sympathetic activity.

In summary, it can be said that the present study shows that exercise has significantly decreased the intraocular pressure and has no correlation with gender in young age group.

It is concluded that moderate aerobic exercise decreases IOP. It would seem reasonable, at present, not to discourage patients who have glaucoma from aerobic exercise; perhaps on the contrary, it should be encouraged and could be suggested adjuvant to pharmaceutical therapy.

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