Impact of Isometric Exercise on IOP

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ABSTRACT

Background & objectives: *Intra ocular pressure (IOP) is influenced by various Physiological variables in the body system like age, sex, diurnal variation, and pregnancy etc. Exercise when performed regularly has beneficial effect on the various systems of the body and Exercise is known to affect IOP, hence this is study is undertaken to know the physiological effect of isometric exercise on IOP.*

Methods: *IOP was recorded by using Schiotz tonometer in 30 healthy male subjects before and after isometric exercise which was done by using hand grip dynamometer at 20% and 40% of predetermined MVC respectively. The results obtained were compared between before and after exercise of the subjects. The statistical analysis of IOP variations was done by using student's t- test.*

Results: *There was a statistically significant reduction in IOP after exhausting isometric exercise. The mean IOP significantly decreased ($p<0.05$), immediately and after 5 minutes of 20% and 40% of predetermined MVC when compared to the IOP recorded before exercise. The mean IOP difference between 20% and 40% of predetermined MVC were also statistically significant ($p<0.05$) when recorded immediately, and after 5 minutes of exercise, suggesting that exercise causes reduction in IOP.*

Conclusion: *This study conclude that exercise has significantly decreased the intraocular pressure, advising exercise might be useful to glaucomatous patients.*

Key words: *IOP, Exercise, Handgrip dynamometer*

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INTRODUCTION

Silent thief of sight that is Glaucoma is a term describing a group of ocular disorders that result in optic nerve damage often associated with increased intra ocular pressure.[1] Increased intraocular pressure is the risk factor for glaucoma and main risk factor for increased IOP are hereditary, race, age and injuries etc. Intraocular pressure (IOP) is the lateral pressure above the atmospheric pressure maintained inside the eyeball in normal condition.[2]

IOP is the result of a complex interplay of the components of aqueous humour dynamics, especially the rate of aqueous production, the resistance to aqueous outflow and episcleral venous pressure[3]. Various physiological factors in the body, like age, sex, diurnal variation, pregnancy, and physical activity[4,5] etc influence the IOP.

Exercise when performed regularly has beneficial effect on the various systems of the body including eye. It is well recognized that IOP changes with physical activity[4,5,12] and exercise[6].Exercise has both short- and long-term effects on IOP. Earlier Studies have demonstrated that physical activity has a beneficial effect in lowering intraocular pressure after dynamic exercise[4,5,7,8] however, the results are inconsistent in few studies[9].

Previous studies also have documented a fall in IOP particularly immediately after the isokinetic exercise.[6,10,11,12] Training of exercise reduces IOP in glaucoma suspected individuals has been documented, and the clinical impression has been recorded that preexisting glaucoma improves with exercise.

More over previous studies have concentrated more on isotonic exercise and lowering effect on IOP of isometric exercise has been done in few studies.

Very few studies have been done to show the changes in IOP during isometric exercise in Indian subjects. Hence the present study was done to investigate the normal physiological response between isometric exercise and IOP in the normal Indian males, to know whether a significant IOP reduction exists between before and after isometric exercise and to know IOP reduction varies with intensity of exercise.

METHODOLOGY

Present study was undertaken in the Department of physiology in Bidar Institute of Medical sciences, Bidar. Healthy male subjects who

were not suffering from any ocular diseases, non obese, non diabetic, and aged between 18-27 years were included in this study. Individuals with history of eye diseases, history of diabetes, refractive errors, eye medications, infectious diseases, history of medical illness, smoking, and alcoholism and age below 18years and above 27 years were excluded from the study. After Oral informed consent was obtained from all the subjects detailed instructions and demonstrations were given to subjects and made familiarized with the setup.

In this study 39 healthy male subjects were studied, out of which 9 were dropped out from the study. As they could not keep their eyes open without pressure and because of non compliance. Hence the statistical analysis was done for 30 subjects.

The study was done on every individual after recording base line parameters like age, height and weight, IOP is recorded before and after exercise. All the readings were taken at the normal room temperature in the morning hours between 10am-12pm to maintain the constancy of testing and to avoid diurnal variation in IOP.

PROCEDURE

Subjects were made to relax for 15 minutes in supine position, and IOP was recorded in all the subjects before and after exercise by using Schiotz tonometer.

Isometric Handgrip Exercise: Isometric exercise is defined as work performed by a muscle with no change in the length of that muscle. Handgrip Dynamometer (HGD) used for isometric exercise in our study was of the spring Hand Grip type from the makers of Inco Labs, Ambala, India. Subjects in supine position resting intraocular pressure was recorded before starting the exercise and the subjects were made to sit and instructed to sustain the handgrip with dominant hand at 20% of the pre-determined MVC (Maximum voluntary contraction) till exhaustion. When subjects were not able to hold the exertion, they were instructed to inform, at that moment IOP was recorded in supine position, immediately, at 5 minutes and at 10 minutes after exercise. MVC was determined before each experiment as the highest value recorded in three trials.

After one hour of rest same procedure was repeated for 40% of predetermined MVC and IOP recorded in supine position, immediately, at 5 minutes and at 10 minutes after 40% of MVC.

PROCEDURE OF IOP MEASUREMENT

IOP was recorded before, immediately, 5 minutes and 10 minutes after exercise respectively. IOP was measured in supine position by using Schiotz tonometer after anaesthetizing the cornea of both the eyes with 4% topical Xylocaine. IOP was recorded first in the right eye and then in the left eye. The mean of three readings was computed separately for each eye. At the end of the procedure antibiotics (eye drop) were installed to prevent cross infection.

Statistical analysis is done by calculating the mean and standard deviation of values before and after exercise. The difference in the mean values between before and after exercise was determined by using t test. The value of 't' was compared at 5% and 1% levels of significance for the corresponding degrees of freedom. Thus $P > 0.05$ was considered as not significant and $p < 0.05$ was considered as significant.

RESULTS

The age of the study group ranged from 19-26 years with a mean of 23.76±1.74 years. A fall in IOP was recorded after exercise, as there was no statistical difference in IOP of both the eyes hence analysis is done for right eye. The mean IOP recorded before exercise and after 20% & 40% of MVC in right eye are shown in table 1 respectively.

Table 1: Mean IOPs with Standard Deviation of study group before and after isometric exercise in Right Eye

		Mean (mm Hg)	Standard Deviation (mm Hg)
Before Exercise		17.36	1.75
After 20% MVC	Immediately	13.87	1.89
	After 5 min	15.54	2.29
	After 10 min	17.12	2.01
After 40% MVC	Immediately	12.69	2.42
	After 5 min	14.25	2.38
	After 10 min	17.22	2.64

On comparison of IOP recorded before exercise and after exercise of 20% MVC and 40%MVC, it was found that there was reduction in intraocular pressure. This reduction was statistically significant ($p< 0.05$) immediately and after 5 minutes of 20% MVC and 40% MVC respectively, but there was no statistically significant reduction in IOP after 10 minutes of exercise as shown in tables (Table 2 & 3).

Table 2: Mean Difference of IOPs between before and after 20% of MVC in Right Eye

Comparison	Mean Difference (mm Hg)	Inference
Before exercise Vs Immediately after exercise	3.49	S*
Before exercise Vs 5mint after exercise	1.82	S*
Before exercise Vs 10 mint after exercise	0.24	NS

NS: Not significant (p>0.05)
S: Significant * (p <0.05)
Vs: (Versus) Difference between before and after exercise

Table 3: Mean Difference of IOPs between before and after 40% of MVC in Right Eye

Comparison	Mean Difference (mm Hg)	Inference
Before exercise Vs Immediately after exercise	4.67	S*
Before exercise Vs 5 mint after exercise	3.11	S*
Before exercise Vs 10 min after exercise	0.14	NS

NS: Not significant (p>0.05)
S: Significant * (p <0.05)
Vs: (Versus) Difference between before and after exercise

When the Intraocular pressure recorded was compared between 20% and 40% MVC there was reduction in intraocular pressure, in both the strength but this reduction was more in 40% of MVC. There was statistically significant (p<0.05) reduction in IOP immediately, and after 5 minutes of exercise. But this reduction was not statistically significant after 10minutes of exercise as shown in table 4.

Table 4: Mean Difference of IOPs between 20% and 40% of MVC in Right Eye

Comparison between 20% and 40% of MVC		Mean Difference (mm Hg)	Inference
Immediately after 20%	Vs Immediately after 40%	1.18	S*
5 min after 20%	Vs 5 min after 40%	1.29	S*
10 min after 20%	Vs 10 mint after 40%	-0.10	NS

NS: Not significant (p>0.05)
S: Significant * (p <0.05)
Vs: (Versus) Difference between before and after exercise

Discussion

Present study was undertaken to know the normal physiological response of isometric exercise on IOP. This study showed a significant fall in IOP immediately and 5 minutes after isometric exercise when compared with before exercise. The results of this study are consistent with earlier studies showing the fall in IOP after exercise.[8,13,14,15,16]

Acute pressure lowering effect on IOP is seen with exercise which also has beneficial effect when exercises are performed for longer term. And exercise training significantly reduces the IOP[12]. The mechanisms underlying exercise induced IOP reduction are not well delineated.

Physiological changes that occur with exercise have been implicated as possible mechanism in the reduction of IOP to exercise. Studies done by Marcus DF and Michael. S showed that with exercise, levels of blood lactate, plasma osmolarity and blood pH also change.[12,13] The maximum fall in intraocular pressure and changes in blood chemistries occur immediately following exercise This might be due to a significant rise in blood lactate, a concomitant increase in plasma osmolarity, and a lowering of blood Ph.[17,18]

Hemo-concentration and dehydration, also account for the greater osmolarity rise seen after exercise.[19] Osmotic dehydration of the globe, reduced aqueous production due to reduced ultra filtration, and a hypothalamic reflex.[20] The increase of plasma osmolarity is greater immediately after exercise and is associated with a decrease in blood pH. The increase in blood lactate immediately after exercise does not account or the entire observed increase in plasma osmolarity[21]. Hyperventilation was also pointed out as a cause of IOP decrease after exercising[7, 22].

Harris reported that low CO_2 pressure in blood is associated with a reduction of IOP after isometric (anaerobic) exercise. In his study he compared IOP drop of individuals who were made isocapnic during exercise by giving carbon dioxide to those who were not given carbon dioxide and thus stayed hypocapnic. They observed a cessation in IOP drop with the blockage of exercise induced hypocapnia and claimed the presence of an indirect

effect of exercise, which lowers IOP by inducing hypocapnia.[22]

Daniel. F. Marcus noted a change in blood chemistry after exercise in human beings which are responsible for fall in IOP after exercise; these changes were rise in blood lactate, increase in plasma osmolarity and fall in blood pH.[13] Stewart RH[23] Noted a consistent decrease in IOP after exercise and this fall could be due to fibrinolytic activity around schlemns cannel. The out flow channels of eye espically around schlemns cannel show fibrinolytic acitivity,[24] such fibrinolysis was postulated to assist in preventing obstruction of the aqueous out flow path ways, and thus participates in the regulation of IOP. As exercise increases systemic fibrinolytic activity.[25] It can be speculated that exercise decreases IOP by increasing the facility of outflow

In another study the release of large quantities of epinephrine and nor epinephrine from adrenal medulla due to the Stimulation of the sympathetic nervous system during exercise is well documented[26,27] and studies reported that epinephrine reduces IOP by lowering outflow resistance and by lowering the rate of aqueous formation[27] and its effects are mediated by stimulating the synthesis of cyclic adenosine monophosphate (cAMP) activation of cAMP decreases IOP by decreasing the production of aqueous humor.[28]

All these date support the concept that increased lactate levels, causing an osmotic outflow of water from the eye and reduced episcleral venous pressure, are the factors involved in reducing the intraocular pressure with exercise. Growth hormone, epinephrine and nor epinephrine may also contribute; these appear to lower episcleral venous pressure and increase aqueous outflow facility and aqueous production.

CONCLUSION

Present study was undertaken to know the normal physiological response of isometric exercise on IOP. This study showed a significant attenuation in IOP immediately and 5 minutes after exercise when compared to before exercise.

In glaucoma degenerative changes may begin at younger age though it's detected at later age, so early screening at younger age and regular exercise may help to prevent glaucoma and might be an adjuvant to topical medication to lower IOP on sustained basis. Knowledge of the normal level of IOP in subjects who perform regular exercise may help glaucoma screeners. There is a scope for further research relating to IOP, mechanism of fall in IOP with exercise and hormonal levels in plasma which influence IOP.

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