EFFECT OF EXERCISE ON INTRAOCULAR PRESSURE IN RELATION TO BODY MASS INDEX

Tejashwini. V. Basarigidad[1,*], Saryu Sain[2], Spoorthi. B. S[3]

[1]Assistant Professor, Department of Physiology, [2]Post graduate, Department of Anatomy, [3]Post Graduate, Department of Preventive and Social Medicine Basaveshwara Medical College, Chitradurga, Karnataka.

***Corresponding Author:**
E-mail: teju23091987@gmail.com

ABSTRACT

Intraocular pressure varies throughout the night and day. The diurnal variation for normal eyes is between 3-6mmHg and the variation may increase in glaucomatous eyes. Hence, we wanted to investigate the effect of exercise on intraocular pressure changes in relation to Body Mass Index. The effect of exercise on intraocular pressure and blood pressure was evaluated in our clinical laboratory in 30 voluntary 1st year Medical Students of Basaveshwara Medical College, Chitradurga, after the institutional ethical clearance. Materials used in the study were Schizont tonometer, Measuring tape, Weighing Scale, Treadmill and Paracaine eye drops. After a resting period, the subject's height and weight were recorded. Paracaine eye drops were instilled in both the eyes and then intraocular pressure recorded using Schizont Tonometer after 2 min so that anaesthetics acts. Then they were asked to walk on Treadmill with average speed till they were exhausted, again intraocular pressure was noted as above with all aseptic precautions. The statistical analysis was done using students unpaired t- test using SPSS software. Results were expressed in terms of Mean and Standard deviation. P value was taken significant at 5 percent confidence level (p<0.05).

Results: *Intraocular pressure was measured according to BMI under two groups, first with group having BMI less than 22 and other in group having BMI more than 22. There was a significant decrease in intraocular pressure after exercise in group two with BMI more than 22. Gender wise comparison of intraocular pressure both before and after exercise did not reveal much significance. Blood pressure was also recorded both before and after exercise which did not reveal any significance in relation to BMI. From our study we conclude that exercise has significantly decreased the intraocular pressure and has a correlation with body mass index in young age group.*

Keywords: *Body mass index; Intraocular Pressure; Exercise.*

INTRODUCTION

Intraocular pressure (IOP) is the fluid pressure inside the eye. Intraocular pressure is mainly determined by the coupling of the production of aqueous humor and the drainage of aqueous humor mainly through the trabecular meshwork located in the anterior chamber angle. Intraocular pressure measurement is also influenced by corneal thickness and rigidity[1]. Ocular hypertension is defined by intraocular pressure being higher than normal, in the absence of optic nerve damage or visual field loss. Current consensus in Ophthalmology defines normal intraocular pressure as that between 10mmHg and 20mmHg[2]. The average value of intraocular pressure is 15.5mmHg with fluctuations of about 2.75 mmHg. Hypotony, or ocular hypotony, is typically defined as intraocular pressure equal to or less than 5 mmHg. Such low intraocular pressure could indicate fluid leakage and deflation of the eyeball[3]. Intraocular pressure varies throughout the night and day. The diurnal variation for normal eyes is between 3- 6mmHg and the variation may increase in glaucomatous eyes. Physical exercise produced a decreased intraocular pressure without significant change in facility of outflow or episcleral venous pressure. The diminution in intraocular pressure was associated with an increased serum osmolarity, but it was believed that this did not account completely for the change. The physiological changes in the eye during exercise are not fully understood. Some studies have demonstrated that physical activity has a beneficial effect in lowering intraocular pressure (IOP) after both isometric (static) [4–8] and dynamic [9–14] exercise. There are, however, few studies on IOP changes during exercise, and the results are inconsistent [15]. Isometric exercise is known to cause a transient increase both in diastolic and

systolic systemic blood pressure. Since normal-tension glaucoma has been found to be related to transient increases in IOP knowledge of how isometric exercise affects IOP may be of clinical importance. Hence, in the present study we wanted to investigate the effect of exercise on intraocular pressure changes in relation with Body Mass Index.

MATERIALS AND METHODS

The effect of exercise on intraocular pressure and Body Mass Index was evaluated in our clinical laboratory in 30 voluntary students of 1st year Medical students of Basaveshwara Medical College, Chitradurga. All individuals were in the age group 18-25 years. Healthy subjects who were not suffering from any infectious diseases or any diseases of eye were included in the present study. Individuals with a history of eye diseases, history of diabetes, past history of medical illness and above 25 or below 18 years of age were excluded. Materials used in the study were schizont tonometer, Sphygmomanometer, treadmill, measuring tape, weighing scale and Paracaine eye drops. The students arrived at clinical laboratory, Department of physiology in the morning between 10.00-11.0AM. They were requested to come in a relaxed condition and quiet mood. The temperature in the laboratory was Between 25 degree Celsius. They were also asked to fill a questionnaire including type of diet consumed whether vegetarian or mixed and physical activity performed on a daily basis, their habit like alcohol etc were noted. After a resting period, the subjects were asked to lie down in supine position on couch and their Blood pressure was recorded. Paracaine eye drops were instilled in both the eyes and then intraocular pressure recorded using Schizont Tonometer after 2 min so that anaesthetic acts. Then they were asked to walk on treadmill with average speed till they were exhausted, again their blood pressure, intraocular pressure were noted as above with all aseptic precautions then their results were noted in the Proforma. Their height in cms and weight in Kgs were noted. The Body mass index was calculated by the formula, BODY MASS INDEX=WEIGHT IN KG/ HEIGHT IN METER SQUARE.

Statistical Analysis: The statistical analysis was done using students unpaired t test using SPSS software Results were expressed in terms of mean and standard deviation. P value was taken significant at 5 percent confidence level ($p<0.05$).

RESULTS

Intraocular pressure was measured according to BMI under two groups as shown in Table- 2. First with group having BMI less than 22 and other in group having BMI more than 22. There was a significant decrease in intraocular pressure after exercise in group two with BMI more than 22. Gender wise comparison of intraocular pressure both before and after exercise did not reveal much significance as shown in Table-1. Blood pressure was also recorded both before and after exercise which did not reveal any significance in relation to BMI as shown in Table -3.

Table No.1: Genderwise Comparision of Intraocular Pressure before and After Exercise

Parameter	Gender	N	Mean	Std.Deviation	t & p value
IOP(Before)	**Male**	16	15.0313	2.1127	t=0.2340
	Female	14	15.2021	1.8596	p=0.815 **NS**
IOP(After)	**Male**	16	12.6688	2.2365	t=0.9350
	Female	14	11.9764	1.7434	p=0.358 **NS**

Note: NS=Non Significant

Table No.2: Intraocular Pressure Before and After Exercise In Relation To BMI

Parameter	BMI	N	Mean	Std.Deviation	t & p value
IOP(Before)	**<22**	**16**	15.4273	2.0722	t=0.6640
	>22	**14**	14.9279	1.9358	p=0.512 **NS**
IOP(After)	**<22**	**16**	13.5182	2.2288	t=2.6630
	>22	**14**	11.6688	1.5736	p=0.013 **SIG**

Note: NS=Non Significant,SIG=Significant

Table No.3: Group statistics of blood pressure both before and after exercise in relation to BMI

Parameter	BMI	N	Mean	Std.Deviation	t & p value
SBP(Before)	<22	11	121.4545	8.0045	t=1.187
	>22	19	118.2105	6.7295	p=2.45 **NS**
SBP(After)	<22	11	130.9091	9.0050	t=0.960
	>22	19	129.8947	7.6731	p=0.745 **NS**
DBP(Before)	<22	11	80.1818	4.5126	t=0.960
	>22	19	78.4211	5.0146	p=0.345 **NS**
DBP(After)	<22	11	76.1818	4.9359	t=0.361
	>22	19	76.8421	4.7756	p=0.721 **NS**

Note: NS=Non-Significant.

DISCUSSION

This study was conducted with the aim of determining whether acute exercise has any effect on intraocular pressure and to determine how the various exercise protocols affect these changes in the intraocular pressure. In our study BMI was also included as a parameter. Comparison of intraocular pressure before and after exercise in relation to BMI showed a significant decrease in subjects whose BMI was >22 as shown in Table-1. The probable reason may be that obesity cause increase in systolic blood pressure leading to decrease in IOP. Further, it is showed that the relationship between intraocular pressure and obesity, IOP value was slightly higher in males than in females also supports the result of the present study. Normally glaucoma is detected at later age; though degenerative changes may begin to occur at younger age itself. In short our study suggest that early screening at younger age and regular isokinetic exercise may help to prevent glaucoma. So isokinetic exercise may also be consider as one of the adjuvant to treatment for glaucoma which is one of the leading cause of blindness in the world. The reduction of IOP after exercise has been the subject of various investigations[16-30]. In normal subjects the intraocular pressure decreases during exercise[31], and its reduction is proportional to the work load[32]. In the present high-powered study we observed that in all groups there was an IOP reduction after aerobic exercise regardless of antiglaucoma eye drop instillation. The present study confirms the fall in intraocular pressure in human beings seen after exercise [33-35].

This might be due to a significant rise in blood lactate, a concomitant increase in plasma osmolarity, and a lowering of blood pH [36-38]. The maximum fall in intraocular pressure and changes in blood constituents occurs immediately following exercise. At 30 minutes, blood pH and plasma osmolarity return to baseline levels, while blood lactate is still elevated and intraocular pressure is still decreased. These changes in blood constituents after exercise are similar to other reported studies [36-38]. 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 for the entire observed increase in plasma osmolarity. Other factors, such as hemoconcentration and dehydration, account for the greater osmolarity rise seen after exercise [39]. In summary we can say that our study shows that exercise has significantly decreased the intraocular pressure and has a correlation with body mass index in young age group.

ACKNOWLEDGEMENTS

Authors are grateful to Basaveshwar medical college chitradurga, for providing facilities to conduct the work.

CONFLICT OF INTEREST

The authors declare they have no conflict of interest

SOURCE OF FUND

The project was funded by an institutional research grant from Basaveshwara Medical College, Chitradurga.

Bibliography:

1. Stewart Duke-Elder, Parsons Diseases of the Eye 12th edition: Churchill, London; 1954: 270-288.
2. Corneal Pachymetry: A prerequisite for Applanation Tonometry by Tanaka in Arch Opthalmol 1998; 116:544-545.
3. Sheila P Sanders, Henderer *et al.* eMedicine - Ocular Hypotony: Arch Ophthalmol -1999; 11 (2): 189.
4. Kielar RA, Teraslinna P, Rowe DG et al. Standardized aerobic and anaerobic exercise: differential effects on intraocular tension, blood pH, and lactate. *Invest Ophthalmol.* 1975;14:782–785. Lanigan LP, Clark CV, Hill DW. Intraocular pressure responses to systemic autonomic stimulation. *Eye.* 1989;3:477–483.
5. Marcus DF, Krupin T, Podos SM, et al. The effect of exercise on intraocular pressure. I.
6. Human beings. *Invest Ophthalmol.* 1970; 9:749 –752.
7. Marcus DF, Edelhauser HF, Maksud MG, et al. Effects of a sustained muscular contraction on human intraocular pressure. *Clin Sci Mol Med.* 1974;47:249–257.
8. Stewart RH, LeBlanc R, Becker B. Effects of exercise on aqueous dynamics. *Am J Ophthalmol.* 1970;69:245–248.
9. Ashkenazi I, Melamed S, Blumenthal M. The effect of continuous strenuous exercise on intraocular pressure. *Invest Ophthalmol Vis Sci.* 1992;33:2874–2877.
10. Kypke W. Physical exertion and relationship between intraocular pressure and acid-base equilibrium (in Dutch). *Ber Zusammenkunft Dtsch Ophthalmol Ges.* 1974;72:259–264.
11. Leighton DA, Phillips CI. Effect of moderate exercise on the ocular tension. *Br J Ophthalmol.* 1970;54:599–605.
12. Lempert P, Cooper KH, Culver JF, et al. The effect of exercise on intraocular pressure. *Am J Ophthalmol.* 1967;63:1673–1676.
13. Martin B, Harris A, Hammel T, et al. Mechanism of exerciseinduced ocular hypotension. *Invest Ophthalmol Vis Sci.* 1999;40: 1011–1015.
14. Myers KJ. The effect of aerobic exercise on intraocular pressure. *Invest Ophthalmol.* 1974;13:74 –76.
15. Dickerman RD, Smith GH, Langham- Roof L, et al. Intra-ocular pressure changes during maximal isometric contraction: does this reflect intra-cranial pressure or retinal venous pressure? *Neurol Res.* 1999; 21:243–246.
16. Ashkenazi I, Melamed S, Blumenthal M: The effect of continuous strenuous exercise on intraocular pressure. *Invest Ophthalmol Vis Sci* 1992, 33:2874-7.
17. Güngör K, Beydağı H, Bekir N, Arslan C, Süer C, Erbağci I, Ergenoğlu T, Aynacioğlu AS: The impact of acute dynamic exercise on intraocular pressure: role of the beta2-adrenergic receptor polymorphism. *J Int Med Res* 2002, 30:26-33.
18. Harris A, Malinovsky V, Martin B: Correlates of acute exercise induced ocular hypotension. *Invest Ophthalmol Vis Sci* 1994, 35:3852-7.
19. Haynes WL, Johnson AT, Alward WL: Effects of jogging exercise on patients with the pigmentary dispersion syndrome and pigmentary glaucoma. *Ophthalmology* 1992, 99:1096-103.
20. Karabatakis VE, Natsis KI, Chatzibalis TE: Correlating intraocular pressure, blood pressure, and heart rate changes after jogging. *Eur J Ophthalmol* 2004, 14:117-22.
21. Kielar RA, Teraslinna P, Rowe DG: Standardized aerobic and anaerobic exercise: differential effects on intraocular tension, blood pH, and lactate. *Invest Ophthalmol* 1975, 14:782-5.
22. Lanigan LP, Clark CV, Hill DW: Intraocular pressure responses to systemic autonomic stimulation. *Eye* 1989, 3:477-83.
23. Martin B, Harris A, Hammel T: Mechanism of exercise-induced ocular hypotension. *Invest Ophthalmol Vis Sci* 1999, 40:1011-5.
24. Mastropasqua L, Carpineto P, Ciancaglini M, Gallenga PE: The effectiveness of dapiprazole in preventing exercise-induced IOP increase in patients with pigmentary dispersion syndrome. *Int Ophthalmol* 1996, 19:359-62.
25. Orgul S, Flammer J: Moderate exertion lasting only seconds reduces intraocular pressure. *Graefes Arch Clin Exp Ophthalmol* 1994, 232:262-4.
26. Passo MS, Goldberg L, Elliot DL: Exercise training reduces intraocular pressure among subjects suspected of having glaucoma. *Arch Ophthalmol* 1991,109:1096-8.
27. Qureshi IA: The effects of mild, moderate and severe exercise on intraocular pressure in glaucoma patients. *Jpn J Physiol* 1995, 45:561-9.
28. Shah P, Whittaker KW, Wells AP, Khaw PT: Exercise-induced visual loss associated with advanced glaucoma. *Eye* 2003, 17(1):112-3.
29. Stewart RH, LeBlanc R, Becker B: Effects of exercise on aqueous dynamics. *Am J Ophthalmol* 1970, 69:245-8.
30. Ozmerdivenli R, Simsek E, Bulut S, Karacabey K, Saygin O: Comparison of the effects of acute and regular exercise on intraocular pressure in Turkish athlete and sedentarians. *Int J Neurosc* 2006, 116(3):351-60.
31. Myers KJ: The effect of aerobic exercise on intraocular pressure. *Invest Ophthalmol* 1974, 13:74-76.
32. Shapiro A, Shoenfeld Y, Shapiro Y: The effect of standardized submaximal work load on intraocular pressure. *Br J Ophthalmol* 1978, 62:679-681.
33. Margaria, R.: The vapor pressure of normal human blood, J. Physiol. 70:417, 1930.

34. Bouhuys, A., Pool, J., Binkhorst, R. A., and Van Leeuwen, P.: Metabolic acidosis of exercise in healthy males, Amer. J. Physiol. 1966;.2: 1040.
35. Dejours, P.: Control of respiration in muscular exercise, *in* Fenn, W. O., and Rahn, H., editors: Handbook of physiology, Sec. 3, Washington, D. C, 1964, American Physiological Society, Vol. 1.
36. Morehouse, L. E., and Miller, A. T.: Physiology of exercise, St. Louis, 1963, The C. V. Mosby Company, p. 131.
37. Becker, B.: The mechanisms of the fall in intraocular pressure induced by the carbonic anhydrase inhibitor, Diamox, Amer. J. Ophthal. 1955; 39: 178.
38. Langham, M. E., and Lee, P. M.: Action of Diamox and ammonium chloride on the formation of aqueous humor, Brit. J. Ophthal. 1957; 41: 65.
39. Marcus, D. F., Krupin, T., Podos, S. M., and Becker, B.: The effect of exercise on intraocular pressure. II. Rabbits, Invest. Ophthal 1970; 9: 753.