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Short Communication

Changes in Ocular Perfusion Pressure in Response to Short Term Isometric Exercise in Young Adults

Ramya C. M.*[1], Nataraj S. M.[2], Rajalakshmi R.[1], Smitha M. C.[3]

[1]Department of Physiology, JSS Medical College, Mysuru, India. [2]Department of Physiology, DWMIMS, Wayanad, Kerala, India. [3]Department of Community Medicine, JSS Medical College, Mysuru, India.

Summary: Ocular Perfusion Pressure (OPP) is the pressure difference between the Mean Arterial Pressure (MAP) and the Intra Ocular Pressure (IOP). Decreased OPP could be a major risk factor for glaucoma. The aim is to study the effect of Isometric exercise on OPP in apparently healthy young adults. Forty apparently healthy young adult volunteers comprising 20 males and 20 females in the age group of 18-21 years were selected among MBBS Phase I students of JSS Medical college, JSSU, Mysore. IOP and BP were recorded. Mean arterial pressure (MAP) and OPP were calculated. There was a statistically significant difference ($p<0.05$) in the mean OPP before and after performing Isometric exercise and between males (50.58±0.72 to 56.85±1.15 mm Hg) and females (49.35 ± 1.66 to 56.71 ± 1.61 mm Hg). Physical activity in the form of Isometric exercise improves ocular blood flow - OPP. Hence regular exercise of prescribed intensity may prove useful for glaucomatous patients which enhance their OPP.

Keywords*:* Ocular perfusion pressure, Isometric exercise, Glaucoma

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**Address for correspondence*: drramyacm@gmail.com

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INTRODUCTION

Glaucoma is the leading cause of blindness in the world. It is a chronic optic neuropathy with characteristic changes in optic nerve head (ONH). The vascular hypothesis suggests that abnormal perfusion of the ONH causes ischemia and poor nutrition of retinal ganglion cells (Zheng et al., 2010). Glaucoma may continue to progress even after the reduction of Intra-Ocular Pressure (IOP) to targeted levels, which indicates that factors others than IOP, affect the pathogenesis.

A relatively new concept of Ocular Perfusion Pressure (OPP), defined as the difference between arterial pressure (BP) and IOP (Christina, 2009). It is an important determinant of ocular blood flow. A decrease in perfusion pressure may significantly decrease the ocular blood flow in absence of vascular autoregulation. Compromised ocular blood flow and deranged vascular auto regulation in the optic nerve head is emerging as an important causative factor contributing to glaucomatous optic neuropathy.

Isometric exercise is a form of physical exercise in which muscles are contracted and held in stationary position. Though isometric exercise increases muscle tension significantly, the length of the muscle remains the same (McArdle et al., 2006). In isometric exercise force is generated at constant muscle length without rhythmic episodes of relaxation. Isometric work intensity is usually described as percentage of maximal voluntary contraction (MVC), the peak isometric force that can be briefly generated for that specific contraction. Lower levels of physical activity are also associated with lower OPP (Jennifer et al., 2011).

Isometric exercise is known to cause an increase in the BP and decrease in IOP. These two components of OPP are strongly influenced by autonomic nervous system and the net result is an increase in the OPP. There are no studies yet on Indian population showing the effect of short term isometric exercise on OPP, particularly in healthy young adults. Hence this study aims to study the short-term effect of isometric exercise on OPP in young healthy adults.

MATERIALS AND METHODS

This comparative study was conducted on 40 healthy young adults of age 18-21 years (20 males and 20 females) who were selected randomly among MBBS students of JSS medical college. Ethical clearance was obtained from the institutional ethical committee, JSS Medical College, Mysuru. Subjects were screened using a questionnaire which included inclusion and exclusion criteria's and by physical examination for their age, history of hypertension, cardiac or pulmonary diseases, eye disorders, other factors affecting IOP, smoking and consumption of alcohols. Subjects were informed about the purpose of the study,

protocol was explained and informed consent was obtained.

Inclusion criteria

The study subjects were in the age group 18-21 years of either sex, non-obese: BMI 18 – 22.9 kg/ m^2 and were normotensives.

Exclusion criteria

Those with pre-existing refractive errors, glaucoma, migraine and any systemic illness, with any drug history affecting IOP, smokers and alcoholics were excluded from the study.

Procedure

Study was carried out in the research laboratory in Department of Physiology, JSSMC, Mysuru, by a single examiner between 3pm to 5pm to minimize the bias of examiners and diurnal variations of IOP. Subjects were instructed about the study before the experiment was done and asked to relax for 15 minutes in supine position. Resting Heart rate was recorded using pulse-oximeter. Resting BP was measured using Mercury Sphygmomanometer and IOP using Schiotz tonometer in supine position. Mean arterial pressure and OPP was calculated using the formula, MAP = DBP+1/3 Pulse Pressure, OPP = 2/3(MAP-IOP) (Hayreh, 2001)

Then subjects were asked to do isometric exercise to their maximum strength with Digital back-leg lift dynamometer to determine Maximum Voluntary Contractions (MVC). 40 % MVC was calculated. Subjects did the isometric exercise at 40 % MVC until the point of fatigue. Both IOP and BP were recorded as the average of 3 sequential measurements in mm Hg in supine posture immediately, at five minutes, ten minutes and fifteen minutes after the exercise. Systolic Ocular Perfusion Pressure (SOPP) was calculated as (SBP – IOP) and Diastolic Ocular Perfusion Pressure (DOPP) was calculated as (DBP – IOP).

Statistical Analysis

Mean and standard deviation were worked out to assess the estimate of various parameters under study. Paired t-test was applied to test the significance of changes in parameters studied. Microsoft Excel and SPSS version 19 software were used for data entry and statistical analyses respectively.

RESULTS

The study included 40 healthy young adults in the age group of 18 to 21 years (male n=20 & female n=20). There was no significant statistical difference between the two groups in terms of age, Body mass index and Waist circumference.

At Rest:

Resting mean values of systolic BP, MAP, Systolic and Mean OPP among males was significantly higher ($p<0.05$) as compared to the female group as shown in Table 1. Baseline IOP, diastolic BP and OPP were also higher in the male group but is statistically non-significant.

After Isometric exercise:

Immediately after exercise, OPP was raised in both male and female groups significantly compared to the resting level. There was a statistically significant difference($p<0.05$) in Mean OPP before and after performing Isometric exercise and between males (50.58±0.72 to 56.85±1.15) and females (49.35 ± 1.66 to 56.71 ± 1.61) as shown in fig 1. Mean increase in male group was 6.27 mm Hg where as in females it was 7.44 mm Hg. Thus, the increase in OPP immediately after exercise was higher in females and was statistically significant. The difference between the two groups was statistically significant and the mean difference was higher in female group compared to that of males for OPP at 5^{th}, 10^{th} and 15^{th} mins after exercise. At the end of 15 mins the OPP almost reached the baseline in both the groups. SOPP and DOPP were also increased immediately after exercise and the mean increase was comparatively higher in females.

Table 1: Resting mean values of SBP, MAP, SOPP and MOPP in both groups

REST	MALE	FEMALE	P value
SBP (mm Hg)	119.8	116.4	0.002*
DBP (mm Hg)	78.4	77	0.144
MAP (mm Hg)	92.19	90.13	0.016*
IOP (mm Hg)	16.33	16.14	0.567
SOPP (mm Hg)	103.47	101.9	0.000*
DOPP (mm Hg)	62.07	61.47	0.123
MOPP (mm Hg)	50.57	49.34	0.005*

* $p < 0.05$. SBP-systolic blood pressure, DBP - diastolic blood pressure, MAP-mean arterial pressure, IOP-intra-ocular pressure, SOPP- systolic OPP, DOPP-diastolic OPP, MOPP- mean OPP

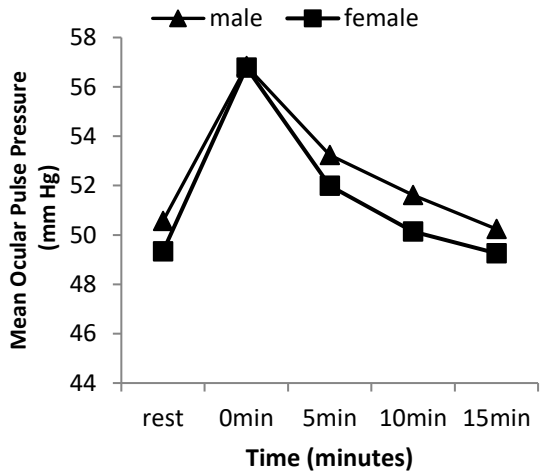

Figure 1: Ocular Pulse Pressure changes before and after Isometric exercise

DISCUSSION

The aim of the conducted work was to study the effect of short term isometric exercise on ocular perfusion pressure in healthy young adults of either gender. This study involved young adults of 18 to 21 years with normal BMI in two groups. IOP, MAP and OPP responses to autonomic function tests like Isometric Exercise was carried out. There was a statistically significant increase in OPP, MAP following Exercise.

In recent years, new knowledge about physical activity like exercise and the associated positive implications on health are gaining clinical significance. Almost all physiological process will be benefited by the regular physical activity. Likewise, exercise is also said to be beneficial for eyes (Hilton, 2003).

In our study we found out that IOP has declined & BP is increased, thus OPP has been increased. This effect could be due the fact that Isometric Leg press exercise can stimulate ocular sympathetic nervous system to increase the facility of outflow of aqueous humor and thus decreases IOP (Sears and Mead,1983) [11]. Stimulation of sympathetic nervous system during and post exercise is well documented and causes the release of large quantities of epinephrine and nor epinephrine from adrenal medulla. This epinephrine released as a result of exercise stimulates synthesis of cAMP. Activation of cAMP decreases IOP by decreasing aqueous humour production (Hilton, 2003).

Many studies have reported that epinephrine reduces IOP by lowering outflow resistance and by lowering the rate of aqueous formation (Richard and Drance, 1967). Also, after leg press exercise there is rise in blood lactate levels. Increased Lactate levels causes outflux of water from eye which is responsible for fall in IOP (Khurana, 2007). Rapid decrease in IOP during the first few minutes of exercise been postulated to be due to osmotic effect of increasing lactate leading to dehydration and decreasing pH, resulting in hypo-secretion of aqueous (Kielar et al., 1975).

Increase in Blood pressure recording has been suggested to be mediated primarily by the central command which is related to number of motor units activated and to reflex effects from active muscle mechanoreceptors (McArdle et al., 2006). The same may also occurs through withdrawal of vagal dominance. Sympathetic stimulation appears to be a secondary mechanism for increasing the HR, BP, as it becomes operative only after first mechanism of vagal withdrawal has been utilized (Martin et al., 1974). The increased systemic pressure post isometric exercise decreases IOP, elevates BP- which in turn produces an elevated OPP (Beck et al., 2003).

In conclusion, the present results indicate that ocular perfusion pressure increases immediately after isometric exercise which is believed to be beneficial for ocular health. Regular exercise also helps to control blood pressure which can help protect capillaries which would otherwise be predisposed to damage by raised blood pressure. Hence exercise offer a safe and simple method for reducing the risk of developing glaucoma and may proves to be useful in normotensive glaucomatous patients. Further studies should be carried out using glaucoma patients to investigate the probable beneficial effect of exercise.

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