Research Article

Ocular perfusion pressure response to short term moderate isotonic exercise in obese young adults

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Abstract

Objective: To study the effect of moderate isotonic exercise on Ocular perfusion pressure in healthy obese young adults. **Method:** 100 healthy young adult volunteers comprising 50 obese and 50 non-obese in the age group of 18-19 years were selected among MBBS Phase I students of JSS Medical college, JSSU, Mysuru. Subjects were asked to perform moderate Isotonic exercise on Treadmill. Heart rate, Intra-ocular pressure (IOP) and arterial blood pressure (BP) were recorded at rest and post- exercise period. Mean arterial pressure (MAP) and Ocular perfusion pressure (OPP) were calculated. **Results:** There was a significant increase in MAP & OPP and a decrease in IOP in post-exercise period in obese group compared to non-obese group [(Obese: MAP=93.93±4.75 to 105.37±4.91; OPP=51.48±3.27 to 61.23±3.25; IOP=16.71±1.08 to 13.53±1.01). (Non-obese: MAP = 91.37±2.71 to 104.41±4.44; OPP = 50.14± 1.57 to 61.05± 2.86; IOP =16.17±0.97 to 12.82±1.24)]. The OPP was significantly high in males (53.49±1.87) than female group (49.47±3.14) at rest. Following exercise OPP was significantly raised in females as compared to males. **Conclusion:** Moderate isotonic exercise proves beneficial to ocular health by increasing the perfusion levels, which may be helpful for glaucomatous patients.

Keywords: Ocular perfusion pressure, Isotonic exercise, Glaucoma.

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INTRODUCTION

Perfusion pressure is defined as the blood flow in any organ, which is computed as the difference between arterial BP and venous BP. In the eye, Intra-Ocular Pressure is equivalent to the venous pressure. Therefore the OPP can be calculated as the difference between the arterial pressure and IOP. OPP is defined as the difference between MAP and IOP[1]. Obesity is defined as "abnormal or excessive fat accumulation that may impair health" by World Health Organisation (WHO)[2]. Obesity is characterized by increased intra-orbital fat leading to elevated episcleral venous pressure with consequent reduction in outflow which may contribute to increase in IOP. Glaucoma is a chronic optic neuropathy, with characteristic changes in the optic nerve head (ONH). In the pathogenesis of glaucoma, a "vascular" hypothesis has been postulated which suggests that the abnormal perfusion of the ONH causes ischemia and poor nutrition of the ganglion cells of the retina[3]. Isotonic/dynamic exercise is known to cause an increase in the BP and decrease in IOP. These two components 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 moderate isotonic exercise on OPP, particularly in obese young adults. Hence this study aims to study the effect of moderate isotonic exercise on OPP in healthy obese young adult group.

MATERIALS AND METHODS

Hundred healthy young adult volunteers comprising 50 obese (25 males & 25 females) and 50 non-obese (25 males & 25 females) in the age group of 18-19 years were selected among MBBS Phase I students of JSS Medical College, JSSU, Mysore. The height and weight of each

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volunteer was recorded and Body Mass Index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters. Waist and Hip circumferences were measured and Waist-Hip ratio (WHR) was calculated. As per WHO guidelines[4], those with BMI 18-22.9 Kg/m^2 were grouped as control and those with BMI >25 kg/m^2 as study group. Ethical clearance was obtained from the institutional ethical committee, JSSMC, Mysore. Subjects were informed about the purpose of the study, the study protocol and the informed consent was obtained. Subjects with pre-existing refractive errors, acute or chronic conjunctivitis, Glaucoma, migraine were excluded from the study.

MATERIALS

- Schiotz tonometer (Reister, Germany)
- Sphygmomanometer
- Stethoscope
- Treadmill (Dynatrac)
- Pulse-oximeter

Study was carried out in the research laboratory in Department of Physiology, JSSMC, Mysore. The study was carried out in a quiet room, 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 Ocular perfusion pressure was calculated using the formula,

MAP = DBP+1/3 PP (PP=pulse pressure)

OPP = 2/3(MAP-IOP)[5]

Thensubjects were asked to perform isotonic exercise using Dynatrac treadmill under modified Bruce protocol. Subjects were asked to do the exercise for 3minutes with a steady speed of 2.7 km/hour at grade 10%. This exercise load is equivalent to stage III of modified Bruce protocol and calculated equivalent METs is approximately. As per WHO classification of grading of exercise[6], this is categorised under moderate level of exercise. IOP, BP were recorded immediately and after 5, 10, 15 minutes after exercise. MAP and OPP were calculated.

STATISTICAL ANALYSIS

Microsoft Excel and SPSS version 19 software were used for data entry and statistical analyses respectively. 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.

RESULTS

Table 1: Physiological characteristics of study and control groups

Parameter	Study Group (n = 50)	Control Group (n = 50)	'p' value
Age (Years)	18.26 ± 0.44	18.26 ± 0.44	1.000
BMI	27.76 ± 2.27	21.28 ± 1.13	0.000**
WHR	0.95 ± 0.08	0.83 ± 0.03	0.000**
MAP (mm of Hg)	93.93±4.75	91.37±2.71	0.001*
IOP (mm of Hg)	16.71±1.07	16.17±0.969	0.010*
OPP (mm of Hg)	51.48±3.227	50.14±1.574	0.010*

*Statistically significant (p<0.05); ** statistically highly significant (p< 0.001)

The results are tabulated below. There was a statistically significant increase in MAP & OPP and a significant decrease in IOP in obese group compared to non-obese group following moderate isotonic exercise.

Table 2: Mean±SD of MAP, IOP & OPP after moderate isotonic exercise in study and control groups

Parameter	Duration	Study Group (n = 50)	Control Group (n = 50)	'p' value
MAP	Baseline	93.93±4.75	91.37±2.71	0.001
	1min post IE	105.37±4.91	104.41±4.44	0.308
	5min post IE	98.89±3.69	97.40±2.83	0.025*
	10min post IE	93.65±2.41	92.96±2.47	0.158
	15 min post IE	93.93±4.75	91.36±2.71	0.001
IOP	Baseline	16.71±1.08	16.17±0.97	0.010*
	1min post IE	13.53±1.01	12.82±1.24	0.002*
	5min post IE	14.80±0.91	15.00±0.90	0.268
	10min post IE	16.13±0.70	16.17±0.97	0.813
	15 min post IE	16.71±1.08	16.17±0.97	0.010*
OPP	Baseline	51.48±3.27	50.14± 1.57	0.010*
	1min post IE	61.23±3.25	61.05± 2.86	0.766
	5min post IE	56.06 ± 2.46	54.93 ± 1.80	0.010*

10min post IE	51.68 ± 1.51	51.17 ± 1.45	0.087 0.010*
15 min post IE	51.48 ± 3.27	50.13 ± 1.57	

*Statistically significant (p<0.05)

Table 3: Gender difference in Mean±SD of MAP, IOP & OPP after moderate isotonic exercise in study group

Parameter	Duration	Males (n=25)	Females (n=25)	'p' value
MAP	Baseline	96.93±2.87	90.93±4.37	0.000**
	1min mod IE	106.45±4.20	104.29±5.40	0.121
	5min mod IE	100.48±3.14	97.31±3.58	0.002*
	10min mod IE	94.83±1.57	92.48±2.55	0.000**
	15 min mod IE	96.93±2.87	90.93±4.37	0.000**
IOP	Baseline	16.70±0.95	16.72±1.22	0.939
	1min mod IE	13.40±0.86	13.66±1.15	0.384
	5min mod IE	14.67±0.77	14.93±1.04	0.312
	10min mod IE	16.24±0.61	16.02±0.78	0.289
	15 min mod IE	16.70±0.95	16.72±1.22	0.939
OPP	Baseline	53.49±1.87	49.47±3.14	0.000**
	1min mod IE	62.03±2.72	60.43±3.58	0.080
	5min mod IE	57.21±1.98	54.92±2.38	0.001*
	10min mod IE	52.40±1.05	50.97±1.57	0.000**
	15 min mod IE	53.49±1.87	49.47±3.14	0.000**

*Statistically significant (p<0.05); ** statistically highly significant (p< 0.001)

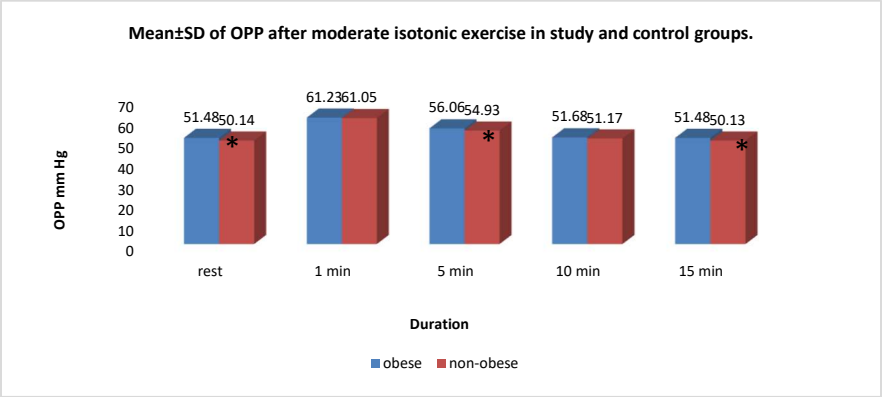

Figure 1: Graph showing Mean±SD of OPP after moderate isotonic exercise in study and control groups

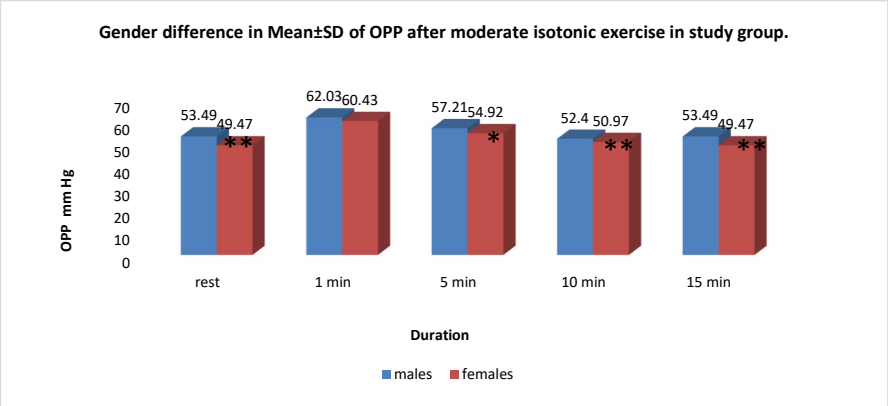

Figure 2: Graph showing gender difference in Mean±SD of OPP after moderate isotonic exercise in study group

DISCUSSION

The aim of the conducted work was to study the effect of moderate isotonic exercise on Ocular perfusion pressure in healthy obese young adults. The Mean±SD of baseline MAP, IOP and OPP were significantly higher among obese group when compared to non- obese group as shown in table no. 1.These readings indicate that there is a high sympathetic tone in obese people. Leptin & other

adipokines, activation of renin-angiotensin-aldosterone axis, insulin resistance all together lead to an elevated blood pressure levels in obese[7]. This leads to a higher OPP values in obese young adult group. Obesity is considered as an independent risk factor for development of many chronic disorders. Prevalence of obesity and over weight is increasing in children and adolescents globally. Earlier studies [8-11]have consistently shown a positive association between obesity and IOP and the Epic-Norfolk Eye study[3] concluded that lower levels of physical activity were associated with lower OPP. It was observed from table 2 and fig. 1, that the OPP increased profoundly in both groups immediately in post-exercise period. During exercise, there will be vasodilation in active muscles partly due to accumulation of metabolites. This leads to a decrease in systemic vascular resistance that is proportional to the involved muscle mass. In order to maintain arterial blood pressure, there will be increased sympathetic activity. This causes vasoconstriction in inactive tissues, like splanchnic bed as well as increased venous return to maintain cardiac filling volume and pressure. The milking effect of muscular activity also leads to increased venous return. Thus the sympathetic over activity causes an increased chronotropic and inotropic action on heart resulting in increased cardiac output, SBP and hence MAP. Studies reported that epinephrine reduces IOP by lowering outflow resistance and by lowering the rate of aqueous formation[12]. Epinephrine produces many of its effect by stimulating the synthesis of cyclic adenosine monophosphate (cAMP). cAMP regulates the activity of protein kinases, these in turn phosphorylate the enzymes and thereby activate or inhibit those key enzymes that control intracellular metabolic pathways. It has been shown that activation of cAMP decreases IOP by decreasing the aqueous humor production[13]. Higher levels of physical activity are associated with lower risk of arterial stiffnessand it suggests that the beneficial effects of physical activity on ocular perfusion may be due to differences in arterial compliance. Exercise leads to increase in the BP, decrease in IOP. These two components are strongly influenced by autonomic nervous system and the net result is an increase in the OPP. Kozobolis et al.[14], who studied the effects of dynamic physical exercise on ocular perfusion pressure (OPP) & ophthalmic artery (OA) blood flow on thirty male subjects concluded that maximal physical exercise increases OPP. Brownlee[15] in his study showed that regular moderate exercise significantly decreased IOP and improved pulsatile ocular blood flow. It was concluded in a study that regular treadmill exercise had the effect of lowering intraocular pressure, so improvement in OPP[16]. A study carried out in Osaka, Japan investigated the control mechanisms for ocular blood flow changes after dynamic exercise and concluded that dynamic exercise improves OPP by producing increased tissue blood flow in the retina in the immediate post-exercise period[17]. A study conducted in Genoa, Italy evaluated the retinal blood flow before and after dynamic exercise to assess the autoregulation of retinal blood flow in young healthy subjects and concluded that in normal subjects, auto regulation is sufficient to maintain the increase in blood pressure following exercise and maintain a stable retinal blood flow[18]. In our study we attained an increased OPP immediately after moderate exercise in both the groups. While comparing the gender difference in OPP of study group, it is observed that there was a highly significant difference in baseline OPP which was higher in males. It may be ascribed to higher MAP in this group. Following exercise, there was a significant increase in OPP in both the gender, but it was noticeably more in females as shown in table no. 3 and Fig. 2. This indicates the autonomic instability in female group. After 15 minutes, OPP returned to baseline values in both gender group.

CONCLUSION

- The baseline Mean arterial pressure, Intra Ocular Pressure and Ocular Perfusion Pressure were significantly higher in obese group.
- Following exercise, there was a significant decline in IOP and an increase in MAP & OPP in obese group as compared to non-obese group.
- Obese females were found to show a large increment in OPP post-exercise period compared to obese male group.
- Therefore, from this study it is concluded that, dynamic exercise is considered beneficial to ocular health, by improving OPP and regular moderate degree exercise can be prescribed in the management of Glaucoma, where ocular perfusion is lowered. Therapeutic exercise programs can be designed to obese, which may prove helpful for maintaining both ocular as well as overall systemic health.

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