

EFFECT OF ISOTONIC AND ISOMETRIC EXERCISES ON INTRA OCULAR PRESSURED. H. Rajendra¹**HOW TO CITE THIS ARTICLE:**

D. H. Rajendra. "Effect of Isotonic and Isometric Exercises on Intra Ocular Pressure". Journal of Evidence based Medicine and Healthcare; Volume 2, Issue 42, October 19, 2015; Page: 7221-7229, DOI: 10.18410/jebmh/2015/980

ABSTRACT: BACKGROUND: Intra Ocular Pressure (IOP) changes following dynamic (Isotonic or Isokinetic) and static (Isometric) exercise. **AIM:** To study the effect of dynamic and static exercises on IOP and blood pressure in the same subject following each type of exercise and to correlate the changes in BP to the changes in the IOP. **MATERIALS AND METHODS:** The study group consisted of 55 volunteers, visually normal as subjects, 30 boys and 25 girls in the age group of 18 to 20 years. Independent measurements of the IOP of each eye were obtained and BP was also measured in the resting state. Keelar Pulsair air impulse tonometer was used in all the subjects for IOP measurement. IOP was measured in the department of Ophthalmology, Teaching Hospital between 08AM to 10 AM on two consecutive mornings in a randomized manner. The subject undertook static exercise using the hand grip dynamometer and towards the end of the test, IOP and BP were measured. The next morning, resting IOP and the BP were measured and the subject undertook the dynamic exercise using the bicycle ergometer and the IOP's and the BP were measured at the end of the test. **STATISTICAL ANALYSIS:** were done using Paired 't' test. **RESULTS:** IOP decreased by 2.58 ± 0.16 mmHg(R) eye & 2.64 ± 0.09 mmHg (L) eye during exercise using Hand grip dynamometer and the systolic and diastolic blood pressures increased by 14.73 ± 0.87 & 12.98 ± 1.01 mmHg respectively. The changes were statistically significant ($P < 0.001$). IOP decreased by 2.55 ± 0.07 mmHg(R) eye & 2.49 ± 0.1 mmHg(L)eye following exercise using bicycle ergometer and the systolic increased by 15.73 ± 1.71 mmHg and the diastolic decreased by 10.83 ± 2.46 mmHg. The changes were statistically significant ($P < 0.001$). There was no correlation between the changes in BP to the changes in IOP. **CONCLUSION:** IOP decreased in both static and dynamic exercises. There was no correlation between the changes in BP to the changes in IOP.

KEYWORDS: Dynamic (Isokinetic or Isotonic) exercise, static (Isometric) exercise, Keelar Pulsair Non-Contact Tonometer, Hand grip dynamometer, bicycle ergometer, Plasma osmolarity.

INTRODUCTION: Intra Ocular Pressure (IOP) is known to be sensitive to many changes in the body system. These include changes in the vascular pressure, serum osmolarity, hormone levels, presence of toxins, changes in the body position and physical exercise.

Decreases of IOP related secondarily to physical exercise has been reported.^{1,2} Studies have shown that IOP rapidly increased up to 15 mm Hg during electroshock therapy and a rapid decrease occur within four minutes after completion of the electroshock therapy.³ Weight lifting (Isometric exercise) produced an increase in the IOP, while running (Isotonic exercise) led to a reduction in pressure. Thus the results are conflicting. The data available in the Indian subjects are very few. More recently raised IOP has been associated with autonomic dysfunction.⁴ The

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purpose of the present study is to explore the effect of Isotonic and Isometric exercises on IOP and blood pressure in the Indian population and to know the validity of such conflicting results. Hand grip Dynamometer and bicycle ergometer are well accepted means for calibrated levels for Isometric and Isotonic exercises respectively.⁵

AIMS AND OBJECTIVES: Studies of the IOP following muscular stimulation as produced by electroshock therapy and physical activity have given seemingly inconsistent results. The two types of exercises were performed in different individuals. The purpose of this project is to investigate further the variation in IOP following two types of exercises namely, isotonic and isometric as measured in the same individuals in various states of physical fitness and to correlate if any the variations in the blood pressure that is in variably associated with the physical exertion.

MATERIALS AND METHODS: 30 boys and 25 girls in the age group of 18 to 20 years served as the subjects for the experiments. Informed consent was obtained from each subject prior to participation.

All participating volunteers were submitted to a questionnaire on systemic and ocular diseases as well as on use of systemic and topical medication.

Each subject then underwent an ophthalmic examination to confirm that both eyes were normal. All subjects underwent physical examination including ocular examination, refractive error determination, cardiovascular and neurological examination. 47 subjects were emmetropic, 12 has corrected visual acuity. No other ocular abnormality was found. Subjects were untrained, and were considered to be in average physical condition.

Inclusion Criteria:

1. Incipient refractive error.
2. IOP less than 21 mmHg.
3. No history of ocular, cardiovascular or neurological disease or any other systemic abnormality.
4. None of the subjects was having any medication that is known to influence IOP.

Exclusion Criteria:

1. IOP less than 9.0 or over 22.0 mmHg in the sitting position, episcleral venous congestion, or any other eye disease capable to cause glaucoma or to influence the measurement of IOP.
2. Gross refractive errors.
3. Use of any topical or systemic medication that might influence IOP in any way.
4. Incapacity to pedal the bicycle.

Ethical Clearance: I would like to make clear the following:

1. The ethical clearance was nonexistent at the time of undertaking this project (15 yrs ago)
2. The HOD of our department then Dr. Srikanth C A, Prof Permission needed to be taken and it was followed. Professor Srikanth is no more now.
3. It does not involve invasive methods.
4. Only volunteers were chosen for the project.

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Hence ethical clearance is not applicable for the present project.

Keelar Pulsair air impulse tonometer was used in all the subjects for IOP measurement. IOP was measured in the department of Ophthalmology, Teaching hospital between 08 AM to 10 AM in the same room. Every IOP measurement was performed at least twice and in case of more than a 2 mmHg difference a third measurement was performed, finally taking into account the mean of the two higher values.

Baseline IOP was measured in the sitting position. And immediately the blood pressure was recorded by means of sphygmomanometer in the same upright position. In case of isometric exercise, blood pressure was recorded from the non-dominant arm. The two types of exercises were under taken on two consecutive mornings separately in a randomized manner.

ISOMETRIC EXERCISE: Resting IOP's was measured in each eye. Blood pressure was measured immediately after IOP measurement. Using the handgrip dynamometer, each subject performed three sustained isometric contractions using the dominant arm to establish their maximum voluntary contraction (MVC). Each maximum grip was sustained for less than two minutes¹¹. For the study, 33% MVC was held for 2.5-3.0 minutes and during the last 30 seconds, measurements for IOP and blood pressure were made.

ISOTONIC EXERCISE: Resting IOP's was measured in each eye. Blood pressure was measured immediately after IOP measurement. For the isotonic exercise, bicycle ergometer was chosen. The subject is instructed to pedal continuously at the rate of 50 cycles/minute for 20 minutes at a constant work load of 60-80 watts in accordance to the preference of each individual so as to perform a moderate-sub maximal-exercise. IOP's of both eyes and blood pressure measurements were taken at the 19th minute of the exercise. For anything, the tests were completed within 10 minutes after completion of the exercise test.

RESULTS: ISOMETRIC EXERCISE: All subjects maintained the handgrip at 33% MVC for 2.5 to 3 minutes. IOP decreased by 2.58 ± 0.16 mmHg(R) eye & 2.64 ± 0.09 mmHg (L) eye during exercise before the handgrip was released. The fall in IOP was statistically significant ($P < 0.001$)

The systolic blood pressure increased by an average of 14.73 ± 0.87 and the diastolic blood pressure increased by 12.98 ± 1.01 mmHg. The rise was statistically significant. ($P < 0.001$)

There was no correlation between the changes in the systolic and diastolic blood pressure to changes in the IOP.

ISOTONIC EXERCISE: Immediately after the exercise, IOP decreased by 2.55 ± 0.07 mmHg(R) eye & 2.49 ± 0.1 mmHg (L) eye following exercise using bicycle ergometer. The fall is statistically significant ($P < 0.001$).

The systolic pressure increased by 15.73 ± 1.71 mmHg and the diastolic pressure decreased by 10.83 ± 2.46 . The pressure change was statistically significant ($P < 0.001$).

There was no correlation between the changes in the systolic and diastolic blood pressure changes to the changes in the IOP.

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	Resting Systolic BP in mmHg	Systolic BP change (↑) during HG in mmHg	'p'	Resting Diastolic BP in mmHg	Diastolic BP change (↑) during HG in mmHg	'p'	Resting IOP in mmHg	IOP change (↓) during HG in mmHg	'p'
Mean	119.16	14.73	<0.001	80.18	12.98	<0.001	17.05(R) 16.75(L)	2.58 (R) 2.64 (L)	<0.001
SD	9.56	0.87		6.34	1.01		2.94 (R) 2.98 (L)	0.16 (R) 0.09 (L)	

Table 1: Isometric Exercise, Hg – Hand Grip

	Resting Systolic BP in mmHg	Systolic BP change (↑) during HG in mmHg	'p'	Resting Diastolic BP in mmHg	Diastolic BP change (↓) during HG in mmHg	'p'	Resting IOP in mmHg	IOP change during HG in mmHg	'p'
Mean	119.16	15.73	<0.001	80.18	10.83	<0.001	16.84(R) 16.73(L)	2.55(R) 2.49(L)	<0.001
SD	9.56	1.71		6.34	2.46		3.06(R) 2.83(L)	0.07(R) 0.1(L)	

Table 2: Isotonic Exercise, Bicycle Ergometry

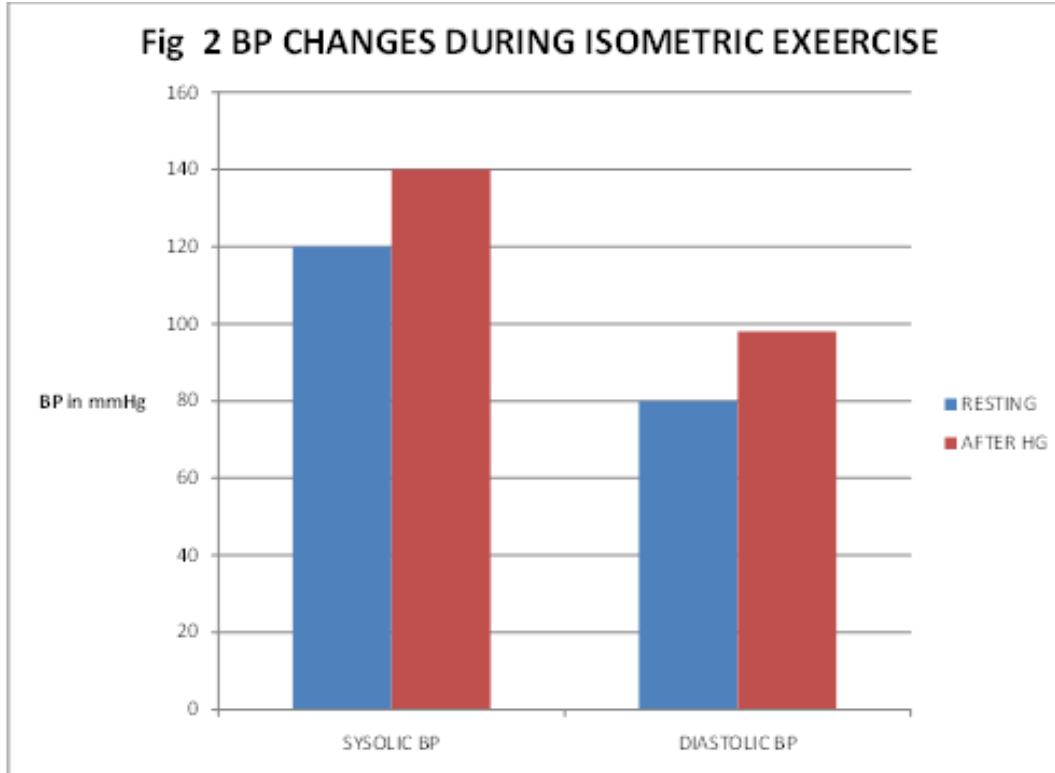
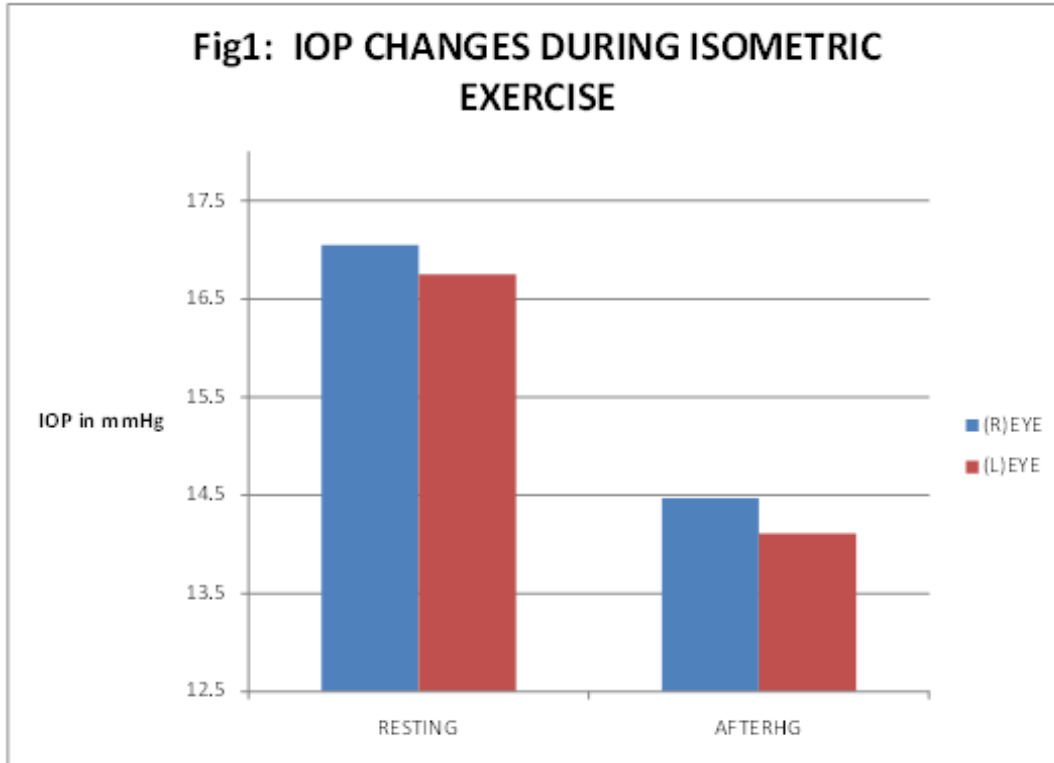
	Correlation
SBP Change	0.910
DBP Change	0.752
IOP Change R eye	0.968
IOP Change L eye	0.963

Table III: Correlation before and after of Isometric Exercise

	Correlation
SBP Change	0.928
DBP Change	0.877
IOP Change R eye	0.972
IOP Change L eye	0.961

Table IV: Correlation before and after of Isotonic Exercise

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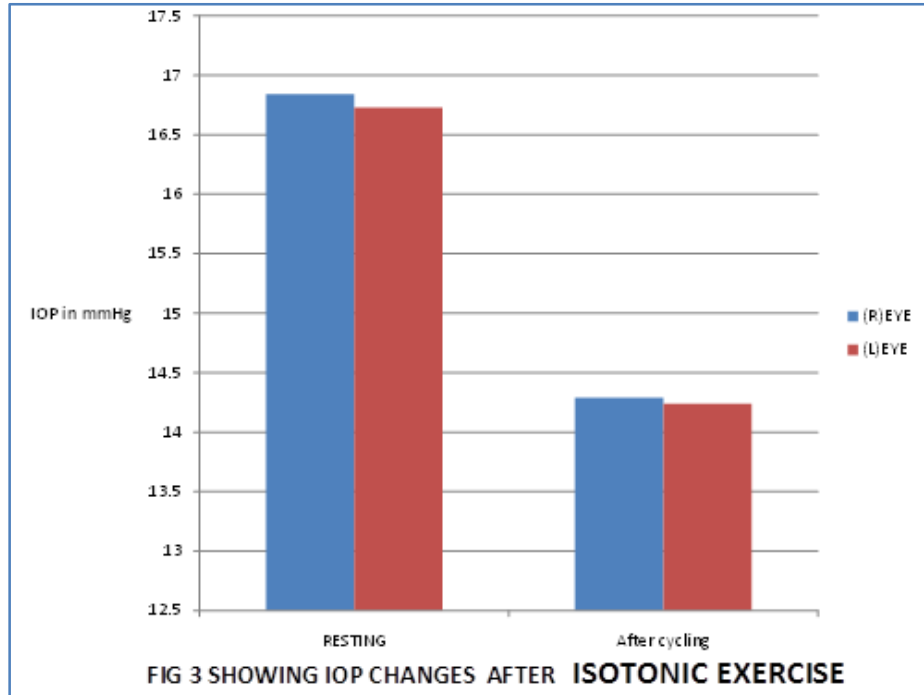
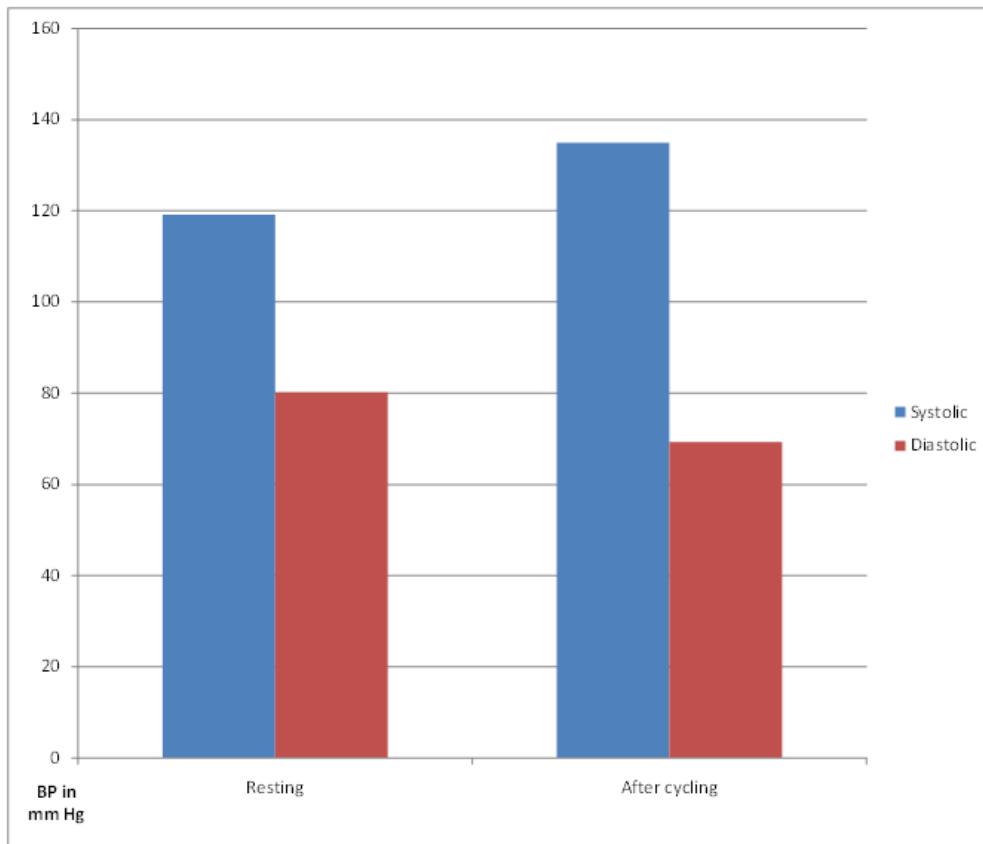


FIG 4 SHOWING BP CHANGES AFTER ISOTONIC EXERCISE



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DISCUSSION: The present study confirms (there is a) the fall in IOP in human beings seen during/after exercise.^{1,6} Increase in serum lactate and a decrease in blood pH and an increase in plasma osmolarity¹ (due to increase in blood lactate, hemoconcentration and dehydration that is associated with exercise which results in hypo secretion of the aqueous^{1,7}) all have been put forward as possible explanations. There is significant rise in blood lactate, a concomitant increase in plasma osmolarity and a lowering of blood pH following exercise on a tread mill.² Marcus et al demonstrated that the post ocular hypotension could be delayed by the application of a sphygmomanometer cuff on the exercising arm, pressure raised above the systolic pressure and was associated with increased blood lactate, decreased pH and increased serum osmolarity.¹ Both these observations indicate that some metabolic factor may be responsible for the fall in IOP. Studies have shown that acidosis lowers IOP.^{8,9}

Exercise produces significant changes in systemic vascular dynamics and could possibly alter episcleral venous pressure. A direct relationship exists between IOP and episcleral venous pressure.¹⁰ However, Stewart et al have shown that no significant alterations in the facility of aqueous outflow or in episcleral venous pressure following exercise, thereby presumably excluding these factors as a possible influence.⁶

There is release of sympathomimetic amines during hand grip contraction.¹¹ Another possibility considered is the release of sympathomimetic amines during exercise and exercise is known to increase plasma adrenaline levels significantly.^{4,12} Astrand et al showed that heart rate and blood pressure increases were higher after static exercise than dynamic exercise.¹³ This cardiovascular response is largely attributable to an increase in sympathetic adrenergic vasomotor tone, resulting in constriction of resistance vessels.¹³ Thus even moderately strong isometric contractions have been found to result in a marked increase in arterial blood pressure.¹⁴ Hence one may postulate that because of increased sympathetic tone, plasma adrenaline levels will be elevated and this may be effective in lowering IOP during hand grip.¹¹ However, it seems unlikely that the epinephrine released by this amount of exercise influences aqueous humor dynamics by a direct effect on the eye.⁶

By determining the IOP at the same hour of the day and in the sitting position, we attempted to exclude all the changes of IOP due to diurnal variation, body position.

The fall in pressure occur despite differences in age, sex, physical condition, initial intraocular pressures and blood pressure patterns which is in agreement with other published work.^{2,15}

CONCLUSION: Fifty five visually normal subjects undertook the two types of exercises, static and dynamic separately on two consecutive mornings. There was a significant fall in IOP during static exercise and the BP, both systolic and diastolic increased significantly. There was a significant fall in IOP following dynamic exercise and the systolic pressure increased and the diastolic pressure decreased significantly. There was no correlation between the changes in the IOP and the changes in the BP following the exercise. However, Patients with glaucoma are to be investigated to see if they too respond to walking (dynamic or isokinetic exercise) with fall in ocular tension. It would seem reasonable at present not to discourage patients who have glaucoma from walking; Perhaps, on the contrary, it should be encouraged.¹⁶⁻¹⁹

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