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ORIGINAL ARTICLE

EFFECT OF VALSALVA MANOEUVRE ON SHORT TERM VARIATION OF INTRA OCULAR PRESSURE

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ABSTRACT: BACKGROUND: Intra ocular Pressure (IOP) changes during Valsalva manoeuver (VM). **AIM:** To study the effect of Valsalva manoeuvre on IOP and the heart rate response. **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 with the subject in the upright position. ECG recorded continuously before, during and after the Valsalva manoeuvre. 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. **STATISTICAL ANALYSIS**: were done using Paired 't' test. **RESULTS:** The mean IOP increased by 5.53±2.138 mmHg during VM. The changes were statistically significant (<0.001). Mean IOP decreased by 2.085±0.367 mmHg during VM in a small proportion of subjects (12%) which was not statistically significant. Mean recovery IOP was also lower than the resting IOP which was statistically significant (<0.001). The Valsalva ratio is calculated as the ratio of the longest RR interval (ms) after the maneuver divided by the shortest RR interval (ms) during the test. Mean Valsalva ratio was normal at 1.687 (range 1.2 - 2.6). **CONCLUSION:** IOP increased during Valsalva manoeuvre in a large number of subjects (88%). Recovery IOP was also lower than the resting IOP during the period of measurement, post VM (over a period of 5 minutes).

KEYWORDS: Valsalva manoeuvre, Keelar Pulsair Non-Contact Tonometer, Valsalva ratio.

INRODUCTION: Intraocular 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, physical exercise, changes in the body position and the Valsalva manoeuvre.

The Valsalva manoeuvre is widely applied in the assessment of function of autonomic nervous system.[1] The Valsalva manoeuvre induces rapid, autonomically mediated fluctuations in heart rate and blood pressure. Although heart rate responses are mainly secondary to blood pressure responses, the result of the Valsalva manoeuvre is generally expressed as changes in instantaneous heart rate. This is because, during the test, it is impossible to measure the blood pressure by means of the standard auscultatory method.[1]

Few studies have documented the IOP changes associated with Valsalva manoeuver. And hardly any studies available in the Indian subjects.

The Valsalva ratio is derived from the Valsalva maneuver. It is the maximum heart rate during the Valsalva maneuver divided by the slowest heart rate after the Valsalva maneuver. It serves as a more general cardiovascular autonomic nervous system test, incorporating cardiac parasympathetic and sympathetic nervous system activity as well as vascular sympathetic nervous system activity.

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AIM OF THE STUDY: It is well recognized that the Intra Ocular Pressure (IOP) changes during Valsalva manoeuvre. Very few studies have been done to show the change in Intra Ocular Pressure during Valsalva manoeuvre. Studies of the IOP changes observed during Valsalva manoeuvre are contradictory, few showing increase and few showing decrease IOP.[2]

Therefore, the aim of this study is to find out the effect on IOP during Valsalva manoeuvre.

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 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, 08 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. Male and female volunteers from 18 to 25 years old, healthy, irrespective of their athletic fitness and who agreed to sign the informed consent of the procedure.
2. Incipient refractive error
3. IOP less than 21 mmHg
4. No history of ocular, cardiovascular or neurological disease or any other systemic abnormality.
5. None of the subjects was having any medication that is known to influence IOP.

Exclusion Criteria:

1. Obesity.
2. Systemic illness related to glaucoma.
3. Use of any topical or systemic medication that might influence IOP in any way.
4. Myopia greater than -2.00, Hypermetropy greater than +3.00, astigmatism greater than 2.00.
5. 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 IOP or the measurement of IOP.
6. Not agreeing to sign the informed consent of the procedure.
7. Subjects who feel dizzy while performing the procedure.

Keelar Pulsair air impulse tonometer[3] 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.

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VALSALVA MANOEUVRE:

1. Let the subject practice at least one Valsalva maneuver for short time (seconds) until the subject is comfortable with the procedure.
2. Wait approximately 1 minute to allow the subject to be relaxed
3. The Valsalva manoeuvre was carried out by asking the sitting subject to take a full inspiration and exhale forcibly (blow) blowing with an open glottis into a mouthpiece connected to the mercury column of a sphygmomanometer with an air leak. A 40-50 mmHg pressure is maintained for 15 seconds by the subject's own visual inspection of the manometer for 15 seconds, pinching one's nose shut (as if blowing up a balloon, to bear down, as if having a bowel movement).
4. The subject should see the expiratory pressure as he can adjust the strain. Give the subject feedback how many seconds left. If the pressure is suboptimal, instruct subject to correct the pressure or repeat the Valsalva maneuver.
5. Wait 3 minutes**.**
6. After the manoeuvre, the subject was asked to continue normal breathing, avoiding deep inhalation or exhalation.
7. The manoeuvre was performed three times at two minute intervals. The expiratory pressure was maintained at 40 mm Hg.
8. Select the most representative maneuver for evaluation.
9. Three IOP measurements were taken during the manoeuvre and the mean IOP values obtained.
10. In the analysis which follows, only those subjects in which clear-cut results were obtained an in which the type of ocular pressure change was similar at the two expiratory pressures were admitted.
11. ECG is continuously recorded before, during and after the VM. From the ECG recording, R-R interval in phase II (continued straining) and R-R interval in phase IV (continued relief) is found to calculate the Valsalva ratio.

RESULTS:

Age and Sex Distribution and Anthropometric Measurements: The average age was 19±1.09 years, height was 163±6.3cms and weight was 58.03±3.8Kgs. There were 30 males, with the ages ranged between 18 and 20 years, with an average of 19.74±0.336 years and their average height 162.13±5.81cms, weight, 60.8±6.4kgs and there were 25 females with their ages ranged between 18 and 21 years with an average of 20.32±0.796 years, average height of 155.4±3.103 cms, average weight of 54.3±5.48kgs.

There was no significant difference between the right eye and the left eye with respect to the IOP and therefore, the pressures for each subject were represented by the average of both the eyes. There is no significant difference between males and females in the IOP.

Two principal IOP patterns were observed. One is a positive pattern, in which the primary alteration is an increase in IOP. (Fig 1, Table!) And the other is a negative pattern, where the most striking alteration is a fall in IOP. (Fig2, Table 2). Statistical significance was done using paired 'T' test.

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POSITIVE NEGATIVE:

Number	%	Number	%
48	87.27	07	12.73

The IOP of all subjects before the Valsalva manoeuvre was 14.40±2.416 mmHg of males was 14.93±2.363 mmHg and of females was 13.76±2.368 mmHg.

The IOP during the Valsalva manoeuvre was 19.93±4.554 mmHg of all subjects and of males 20.40±4.32 mmHg and females was 19.36±4.847 mmHg.

The IOP after the VM (recovery IOP) is 13.47±2.667 mm Hg of all subjects, 14.43±2.726 mmHg in males and 12.68±2.410 mmHg in females.

The mean difference of IOP before and during the Valsalva manoevre was 5.53±2.138 mmHg of all subjects, 5.47±1.957 mmHg of males and 5.6±2.479 mmHg of females.

The mean difference of IOP during the Valsalva manoevre and after the Valsalva manoeuvre was 6.46±1.887 mmHg of all subjects 5.97 mmHg of males and 6.68±2.437 mmHg of females.

The mean difference of IOP before the Valsalva manoevre and after the Valsalv manoeuvre was 0.93±0.251 mmHg of all subjects 0.50±0.363 mmHg of males was and 1.08±0.042 mm Hg of females.

The mean difference (Increase of IOP) (Resting IOP –IOP during VM) was 6.529±1.259 in 87.27% of subjects. The increase was statistically significant (P<0.001).

The mean difference (Decrease of IOP) (Resting IOP – IOP during VM) was 2.085±0.367 mmHg in12.73% of subjects which was not statistically significant (P=0.0739).

In all the subjects, the mean Valsalva ratio was normal at 1.687 (range 1.2 - 2.6).

There is no correlation between age, sex or resting IOP or IOP during Valsalva maneuver.

PAIRED 'T' TEST:

Resting IOP in mm Hg	IOP during Valsalva manoeuvre in mm Hg	'P' value
14.4±2.416	19.93±4.554	<0.001

Table I: IOP Of all Subjects Before Valsalva Manoeuvre (Sitting, Resting Iop) And During Valsalva Manoeuvre

IOP During Valsalva manouvre in mm Hg	IOP after Valsalva manoeuvre (recovery) in mm Hg	'P' value
19.93±4.554	13.47±2.667	<0.001

Table II: IOP of All Subjects during Valsalva Manoeuvre and After Valsalva Manoeuvre (Recovery Iop)

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Resting IOP in mm Hg	IOP after Valsalva manoeuvre in mm Hg	'P' value
14.4±2.416	13.47±2.667	<0.001

Table III: IOP of all Subjects before Valsalva Manoeuvre (Sitting, Resting Iop) and After Valsalva Manoeuvre (Recovery Iop)

Resting IOP in mm Hg	IOP during Valsalva manoeuvre in mm Hg	'P' value
14.623±2.502	21.152±3.761	<0.001

Table IV: IOP of all subjects before valsalva manoeuvre (sitting, resting iop) and during valsalva manoeuvre showing positive response

Resting IOP in mm Hg	IOP during Valsalva manoeuvre in mm Hg	'P' value
14.571±2.168	12.486±1.801	0.0739

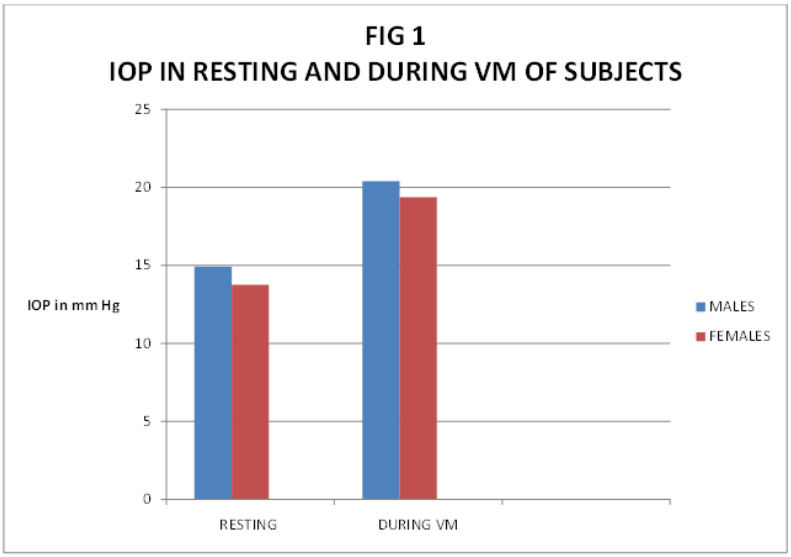
Table V: IOP of all subjects before valsalva manoeuvre (sitting, resting iop) and during valsalva manoeuvre showing negative response

'T' TEST:

	Males	Females	'P' value
Age	18.80±0.887	18.88±0.726	0.714
Resting IOP	14.93±2.363	13.76±2.368	0.073
IOP during VM	20.40±4.32	19.36±4.847	0.493
Recovery IOP	14.43±2.726	12.68±2.410	0.041

Table VI

FIG 1
IOP IN RESTING AND DURING VM OF SUBJECTS



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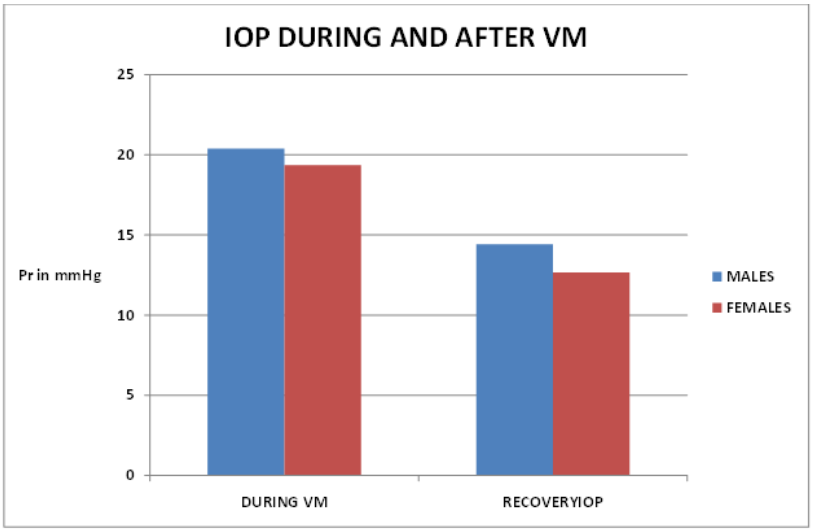

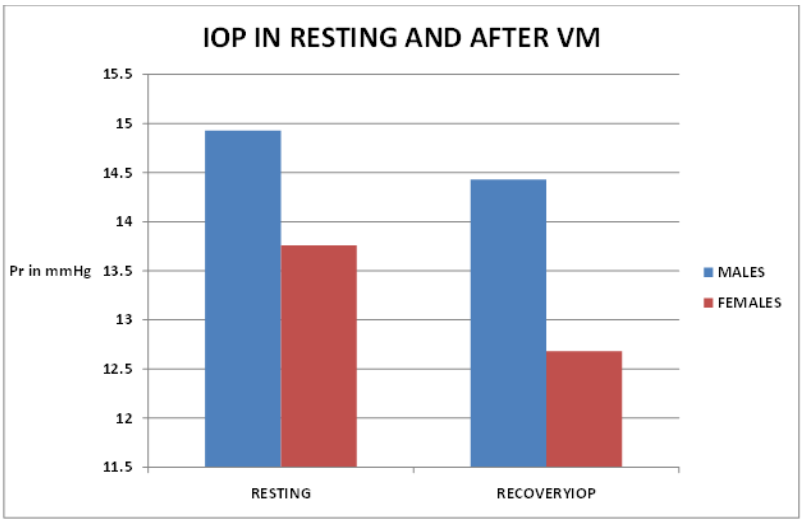

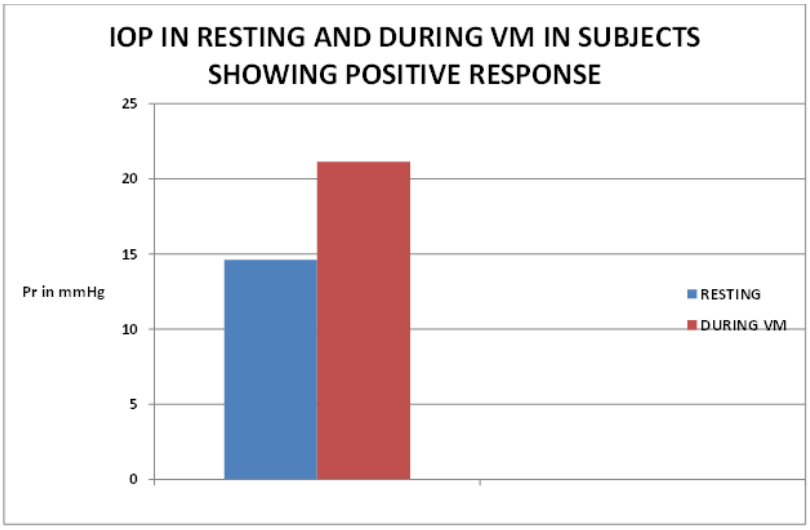

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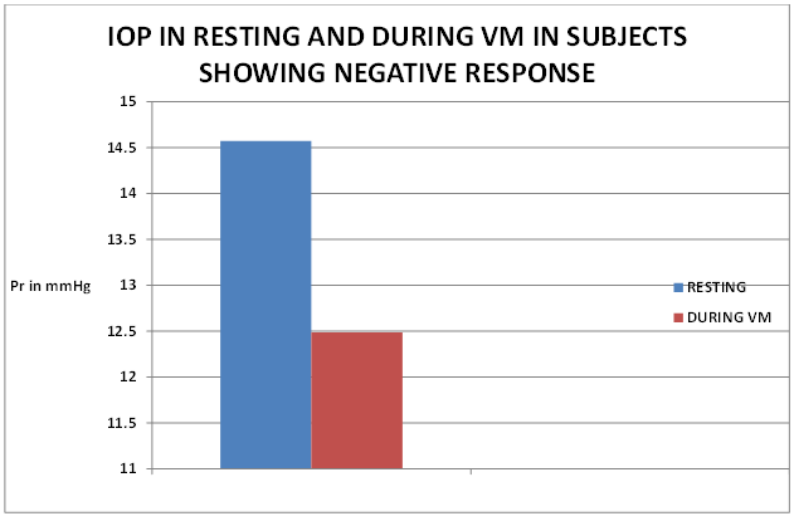

Fig. 6: Sphygmomanometer with mouth piece

DISCUSSION: The Valsalva manoeuvre[4] is accompanied by a variety of complex hemodynamic events and involves both sympathetic and parasympathetic autonomic responses.

Phase 1: (Straining starts).

BP increases, because

- Transient increase in return of blood to the left side of the heart.
- Increased intrathoracic pressure transmitted directly onto the aorta.

HR decreased due to increased BP.

Phase 2: (Continued straining). BP drops initially because of decreased cardiac output secondary to decreased venous return.

- Stimulation of baroreceptors
- Reflex compensation via sympathetic stimulation

Thus,

- HR increased
- Peripheral vasoconstriction
- BP later restored (or even exceeds baseline level).

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Also,

- Pulse pressure decreased.
- Cardiac output still decreased.

Phase 3: (Release of straining). BP decreases because (essentially reverse of phase 1)

- Transient decrease in return of blood due to removal of the squeeze on intrapulmonary vessels.
- Removal of pressure on aorta.

HR increased further;
HR unchanged because the phase is very brief.

Phase 4: (Continued relief).

- Return of normal venous return to heart.
- Cardiac output returns to near normal.
- BP overshoots above the baseline initially because of vasoconstriction.
- Baroreceptor inhibited.
- Reflex vagal stimulation.

Thus,

- HR decreased.
- Peripheral vasodilation.
- -> BP later restored to normal.

The most likely mechanism for the significant rise in IOP during this manoeuvre is secondary to the effect of increased intrathoracic pressure on the great veins of the head and neck. Raised venous pressure is transmitted to the ocular veins and indeed a relationship exists between venous pressure and intrathoracic pressure, IOP=6.51+0.82, venous pressure 24 mmHg[5]. The elevated venous pressure may be communicated through the jugular, orbital and vertex veins to the choroid, bringing about a vascular engorgement and increase in the volume of this tissue. This comes despite the associated lowering of arterial pressure and give rise to a rapid increase of IOP.

It is somewhat more difficult to account for the negative response seen in a small number of subjects. Here one must assume that the falling arterial pressure head overshadows the elevation of venous pressure and that a decrease in choroidal volume, intra ocular volume and IOP is the net result of these hemodynamic events[6].

Recovery IOP: The low IOP observed after the Valsava manoeuvre, is difficult to explain. Episcleral venous pressure is significantly raised during the Valsalva manoeuvre, thereby decreasing the facility of outflow and precipitating elevation of IOP. Upon termination of the manoeuvre, acute decrease in intrathoracic pressure will inevitably be accompanied by decreased episcleral venous pressure, increased outflow of aqueous and therefore lowering of IOP.[5] The decrease in IOP which follows cessation of expiratory effort may result from evacuation of choroidal blood when the venous pressure falls and local reflex vasoconstriction accompanying the fall in systemic blood pressure.[7,8]

Monitoring the heart rate changes during the Valsalva manoeuvre would be objective indicator of the subject's performance.[9]

CONCLUSION: Resting IOP was measured in 55 healthy subjects with no ocular pathology with age range 18-20 years by using Non-Contact Keeler Pulsair tonometer in a teaching Hospital between 08AM to 10AM. Heart rate was monitored by recording the ECG and noting the R-R interval.

IOP increased in 87.27% of the subjects and IOP decreased in 12.73% of the subjects during the Valsalva maneuver. The rise in mean IOP from the baseline was statistically significant. The fall in IOP noted in a small percentage of subjects was not statistically significant. The mean difference between the Valsalva maneuver procedure IOP and the recovery IOP was also statistically significant. The Valsalva ratio was found be normal in all subjects. It is recommended that patients with ocular hypertension or glaucoma refrain from this activity.

ETHICAL CLEARANCE: Not applicable as no invasive techniques are being used. This project was undertaken 10 years ago which, at that time ethical clearance never existed.

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