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Research Article

# Effect of Accommodation on Intra Ocular Pressure in Stable Myopes and Emmetropes

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## Abstract

**Purpose:** To compare the changes in intraocular pressure (IOP) of Emmetropes and Stable Myopes before and after accommodation.

**Study Design:** Cross-sectional Descriptive study design.

**Place and Duration of Study:** Madinah Teaching hospital ophthalmology department from October 2015 to April 2016.

**Materials and Methods:** A total of 53 subjects were included in this study after approval from ethical review board/committee. Inclusion criteria for this study was Twenty three Emmetropes (without any refractive error), and thirty Myopes out of which Twenty were low Myopes (-1.00 to -2.75) and Ten were moderate Myopes (-3.00D to -6.00D). While subjects with accommodation spasm, accommodation insufficiency, cataract, aphakia, Pseudophakia and any disease affecting accommodative ability were excluded from study. Informed consent of the patient was taken prior to their inclusion in the study.

**Results:** Mean age of 53 subjects included in this study was 20.69 years. 23 were Emmetropes and 30 were Myopes. Out of 30 Myopes, 20 showed significant raised IOP after induced accommodation. Cylindrical value did not exceed 1.50D. Mean increase in IOP (represented by plus sign) was +1.425 ± 0.90 mmHg in stable Myopes. While mean decrease in IOP of -1.476 mmHg was seen in Emmetropes after induced accommodation. When Pearson Chi Square test was applied it showed significant association of refractive status and changes in IOP with P value of 0.018 after induced accommodation.

**Conclusion:** There was significant increase in Intraocular Pressure (IOP) in Myopes after induced accommodation of 3diopters.

**Keywords:** Accommodation; Intraocular Pressure (IOP); Myopes; Emmetropes

## Introduction

Accommodation is a reflex activity of the eye and Structures directly involved in the process of accommodation are ciliary muscles, crystalline lens and Zonular fibers [1].

Accommodation happens by constriction (forward and internal advancement) of the ciliary muscle and loosening of the zonules connecting the ciliary body with lens; thus, the lens thickens and turns out to be more curved resulting in increased refractive power of eye [2]. Along with increased lens thickness, depth of anterior chamber is decreased and axial length increased [3]. Eye converge at near and pupil constricts [4].

Ocular accommodation is not just a mechanism for altering curvature of the crystalline lens of the eye, it also enables aqueous humor outflow from posterior chamber through pupil to anterior chamber and drainage through trabecular meshwork [5].

Aqueous humor is produced (2.0 - 2.5 micron Litre/min) by epithelium of ciliary processes which are connected to lens via suspensory ligaments and facing posterior chamber [6,7].

Intraocular pressure (IOP) is the pressure inside the eye applied by aqueous humor. IOP in the range of 10-20 mmHg is normal. It is characterized by the equilibrium between aqueous humor production and its drainage. IOP control within the normal range is important to keep up the anatomical conditions essential for ideal refraction and in this manner, vision [8,9].

IOP (a type of mechanical force) has been known to be one of the many factors to initiate and progress myopia. Several studies

have shown that mean IOP in Myopes was significantly higher than it was seen in the Emmetropes and Hypermetropes. Results of a recent research done by Liu Y., *et al*. say that it is the variation in IOP that might be responsible for the progression of myopia [10].

## Materials and Methods

It was a cross-sectional comparative study. Total 53 subjects were examined excluding patients with accommodation spasm, accommodation insufficiency, cataract, aphakia, Pseudophakia and any disease affecting accommodative ability under the light of inclusion and exclusion criteria. First of all visual acuity was taken for both near and far distance. After objective refraction, spectacle correction was given through subjective refraction. To determine the relationship between intraocular pressure (IOP) and accommodation, each subject was asked to look as far as they can for a while to ensure that subjects do not use any accommodation and IOP was measured through air puff tonometer (without accommodation). Next, each subject wore a lens of -3 D (with full correction on) and gazed at near test-object for 5 minutes to induce 3Diopters of accommodation. After 5 minutes of accommodation IOP was measured again immediately. Data was analyzed by SPSS 20 using Chi square test, descriptive statistics and frequency tables.

## Results

Mean age was 20.69 ± 3.67 years (Table 1) for Emmetropes and Myopes. Out of total 53 subjects, 23 were Emmetropes and 30 were Myopes. Mean increase in IOP (represented by plus sign) and decrease in IOP (represented by minus sign) was +1.42 ± 0.90 mmHg and -1.47 ± 1.37 mmHg respectively in Emmetropes and Myopes shown in tables below. Pearson Chi Square test was applied it showed significant association of refractive status and changes in IOP (P=0.018) with induced accommodation (Table 6).

| Total no of subjects | Minimum Age (Years) | Maximum Age (Years) | Mean | Std. Deviation |
|---|---|---|---|---|
| 53 | 12.00 | 30.00 | 20.6970 | 3.67515 |

**Table 1:** Age distribution among patients with myopia and emmetropia.

| | N | Minimum (mmHg) | Maximum (mmHg) | Mean (mmHg) | Std. Deviation |
|---|---|---|---|---|---|
| Intraocular pressure value before accommodation | 23 | 11.0 | 22.7 | 16.758 | 3.0757 |
| Intraocular pressure after accommodation | 23 | 10.7 | 20.0 | 16.084 | 2.5717 |
| Valid N (listwise) | 31 | | | | |

**Table 2:** Mean IOP values before and after accommodation in emmetropes.

| | Total N | Minimum Decrease in IOP (mmHg) | Maximum Decrease in IOP (mmHg) | Mean (mmHg) | Std. Deviation |
|---|---|---|---|---|---|
| IOP difference before and after accommodation | 21 | -0.2 | -4.4 | -1.476 | 1.3769 |
| Valid N (listwise) | 21 | | | | |

**Table 3:** Mean value of IOP decreased after accommodation in emmetropes.

2 out of 23 Emmetropes showed no change in intraocular pressure,that is why they were excluded to avoid changes in results.

| | N | Minimum Increase in IOP (mmHg) | Maximum Increase in IOP (mmHg) | Mean | Std. Deviation |
|---|---|---|---|---|---|
| IOP Difference before and after accommodation | 20 | +0.3 | +3.0 | + 1.425 | 0.9014 |
| Valid N (listwise) | 20 | | | | |

**Table 4:** Descriptive statistics of Mean value of IOP increased after accommodation in myopes.

| | Total N | Minimum (mmHg) | Maximum (mmHg) | Mean (mmHg) | Std. Deviation |
|---|---|---|---|---|---|
| Intraocular pressure value without accommodation | 35 | 11.3 | 22.7 | 17.609 | 3.4087 |
| Intraocular pressure after accommodation | 35 | 12.3 | 23.3 | 17.589 | 2.6573 |
| Valid N (listwise) | 35 | | | | |

**Table 5:** Descriptive statistics of mean IOP values before and after accommodation in myopes.

| | Value | df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | 5.630[a] | 1 | 0.018 | | |
| Continuity Correction[b] | 4.493 | 1 | 0.034 | | |
| Likelihood Ratio | 5.755 | 1 | 0.016 | | |
| Fisher's Exact Test | | | | 0.024 | 0.016 |
| Linear-by-Linear Association | 5.542 | 1 | 0.019 | | |
| N of Valid Cases | 64 | | | | |

**Table 6:** Chi-square tests for the association between refractive status and changes in IOP.

## Discussion

There are few researches on relation of status of refractive error and Changes in IOP seen after induced accommodation, present research also covers the aspect of effect of induced accommodation on intraocular pressure in Emmetropes and stable Myopes. It is different from previous studies in one aspect that intraocular pressure was measured by Air puff tonometer instead of Goldman which was used in most studies. The advantage of Air puff NCT over Goldmann is that Air puff NCT takes less time for the patient adjustment as compared to Goldman applanation tonometer which comparatively takes more time. Second reason is that amount of accommodation induced by using -3.00D lens can be changed during the time taken for inserting flouresceine dye, anaesthetic drops and adjusting patient. IOP measured by Goldmann tonometer is largely affected by corneal thickness while Air puff Non contact tonometer (NCT) excludes the corneal thickness.

Previously it was assumed that accommodation doesn't affect IOP in different refractive states but there have been many researches recently which showed positive relation between accommodation and IOP in different refractive errors. Present study also shows that accommodation affects IOP differently in Emmetropes and stable myopes.

Changes in Schlemm's canal and trabecular meshwork occur during accommodation facilitating aqueous humor drainage and maintain IOP [11].

A study done by Huibin and others on 40 Emmetropes and 46 progressive Myopes has shown results that no difference is seen between IOP values of Emmetropes (+/-0.50D) and Myopes (-0.75D to -12.50D) without accommodation (16.22 ± 4.11 vs 17.01 ± 3.72) which resembles the results of present study done on 31 Emmetropes (<-0.50D) and 35 Myopes (-1.00D to -6.00D) also showing no significant difference in Emmetropes and Myopes before accommodation (16.7+ 3.07 and 17.6 + 3.40 mmHg respectively) with mean difference of 0.851mmHg. They also found that there was transient elevation of IOP in progressive Myopes after stimulated accommodation. Present study also found the same results with transient increase in IOP in 20 out of 30 stable Myopes [12].

Significant reduction in IOP is suggested with accommodation stimulated in progressive myopes e.g. Reduction in intraocular pressure was reported in another study done by Robert., *et al*. including 30 subjects to see the effect of accommodation. Same results were seen when Read and others studied the effect of accommodation on intraocular pressure and ocular pulse amplitude in 17 young adult emmetropes and 15 myopes with 2 minutes of induced accommodation. They found that intraocular pressure and ocular pulse amplitude significantly lowered after accommodation in myopes when measured with icare rebound tonometer [13,14].

Induced-accommodation by reading or writing lowers Intraocular pressure in healthy individuals (Emmetropes) [15,16].

Difference in IOP values between myopes, emmetropes and hypermetropes. They concluded that intraocular pressure is relatively higher in myopes than in emmetropes and hypermetropes. He studied the myopia progression in 49 children for 2 years and found that myopia progressed at the rate of 1.14D per 2 years. Their conclusion resembles the outcomes of present study in which mean

IOP of myopes is higher than mean IOP of emmetropes (17.6 mmHg and 16.7 mmHg relatively) by an amount of 0.08 mmHg [17].

Similar results seen by Yan and team when they studied the intraocular pressure variation induced by accommodation in 195 progressing Myopes, 75 stable Myopes and 48 Emmetropes. Results of study were such that no significant change was seen in IOPs in Myopes and Emmetropes before accommodation but decreased in IOP was seen after accommodation in low and moderate Myopes and elevation in IOP after accommodation in progressive Myopes. In present study IOP decreased after accommodation in Emmetropes and relatively decreased in 15 out of 35 (low and moderate) Myopes. The reason behind must be the forward displacement of lens, decrease in anterior chamber depth and increased in lens thickness during accommodation as proposed by Huibin and others [18].

While working on smartphones accommodation is activated. In such a study done by Ahnul., *et al*. on 39 healthy individuals, changes in intraocular pressure were measured before, during and after using smartphones. Significant IOP raise was observed especially in dim-light [19,20].

More and detailed study is needed for this topic because there are only few researches that discovered the relationship between accommodation and intraocular pressure in different refractive errors and hence not too much data is available regarding this aspect.

Although slight change occurs in intraocular pressure upon inducing accommodation, it is confirmed that it does change intraocular pressure in myopia. It is recommended that all clinical personnel should be aware of this knowledge and IOP measurement must be included in practice along with the subjective refraction of patients with myopia. Myopic patients should not be over-corrected because more minus number activates the accommodation which can elevate the intraocular pressure and consequently myopia.

## Conclusion

Present study shows the significant association between accommodation and intraocular pressure in both Myopes and Emmetropes. intraocular pressure reduced in Emmetropes although insignificantly but significantly increased in most of Myopes.

## Ethical Approval

The study was approved by institutional ethical review board/ committee.

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