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Accomodative Responces under Monocular and Binocular Conditions in Symptomatic and Asymptomatic Subjects

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Abstract: *The aim of the study was to compare accommodative responses under monocular and binocular conditions for symptomatic and asymptomatic subjects. A sample population of 70 college students of Ahmedabad were selected, divided into symptomatic and asymptomatic according to Vision quality scale. Monocular estimation method was used to evaluate accommodative lag under monocular and binocular conditions. Covertest and Maddox rod were used to detect and quantify the amount of heterophoria. The mean age of symptomatic and asymptomatic participants was 20.75±2.28 and 20.00±0.98 respectively. The monocular accommodative lag ranges from -1.00Ds to +1.75Ds with a mean of 0.33±0.63 in symptomatic subjects. While the binocular lag ranges from - 1.00Ds to +1.75Ds with a mean of 0.33±0.75. In asymptomatic subjects monocular lag ranges from - 1.00Ds to +1.25Ds with mean of 0.58±0.23 while binocular lag ranges from -1.25Ds to +1.00Ds with mean of 0.55±0.24. In symptomatic subjects distance phoria ranged from -1.00 ΔD to +1.00ΔD and in asymptomatic range of distance phoria was -6.00ΔD to -8.00 ΔD. The mean distance phoria in symptomatic subjects was 0.157±0.577 and in asymptomatic subjects was 0.23±1.51.*
There was no significant difference in accommodative lag between monocular and binocular conditions in case of symptomatic and asymptomatic participants.
Key Words: *Accommodative responses, Monocular estimation method, Accomodative lag, vision quality scale*

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I. Introduction

Accommodation is the process by means of which the optical system of eye varies its focal length in response to the visual stimulus. This process is mediated by ciliary muscles and involve and increase in vergence of light brought about by crystalline lens[1]. This reflex is controlled by parasympathetic nervous system and it involves three responses together i.e. Accommodation, Convergence and pupilary constriction[2].

Accommodation may be specified either in terms of the accommodative stimulus or the accommodative response[3]. The accommodative response can be measured clinically by measuring the amount of accommodative lag. Dynamic retinoscopy is the only objective method to find out the amount of accommodative lag[1].

Accommodative response in symptomatic and asymptomatic subjects is an area of current interest in optometry research. Accommodative response may be greater then, equal to or less than accomodative demand. Binocular vergence interactions is a major factor affecting accommodative response[3].

Lag of accommodation monocularly as well as binocularly is linked to amount of phoria leading to near discomfort[3]. It could be assumed that a large change in accommodative response from monocular to binocular conditions could be associated to anomalous binocular accommodative response and thus greater likelihood of symptoms[4] .

The study was aimed to compare accommodative response in monocular and binocular conditions for symptomatic and asymptomatic subjects, and to find out if MEM Retinoscopy can be used as a rapid screening tool for accommodative and binocular vision anomalies.

II. Material And Methods

The study was carried out on 70 undergraduate university students from Gujarat University within a period of November 2017 to September 2018. Participants were divided into two groups Symptomatic and Asymptomatic according to the vision quality scale. Vision Quality Scale consisted of nine questions in Likert scale with six possible responses to each with 6 representing the highest frequency and 0 representing the lowest frequency of symptom occurance. The nine items were converted into percentage.

Subjects with visual acuity 6/6 in each eye and near visual acuity N6 at 40 cm in each eye were included. Subjects who had presence of manifest squint, positive history of any ocular or systemic pathology or history of eye or head trauma were excluded.

Visual acuity was measured using snellen's visual acuity chart. Refractive error was determined objectively by retinoscope and refined by subjective refraction using fogging technique and duochrome balance.

Heterophoria was determined by covertest and quantified by Maddox rod test.

Accommodative response was measured by measuring amount of accommodative lag. The monocular estimation method was done at 40 cm with subjective correction in place. Card with printed letters/ pictures or words mounted on retinoscope. Subjects were asked to read words, swept the retinoscope beam, observed the motion of reflex and quickly changed lenses to neutralize the reflex. The lowest power of lens that neutralized the reflex was recorded for each subject. This procedure was done monocularly (by closing fellow eye) as well as binocularly.

Near point of accommodation was measured in centimetres with help of pushup test, monocularly as well as binocularly. Accommodative target with N8 size was positioned at 50 cm in front of patient's line of sight. Near point of convergence was measured in centimetres with help of pushup test. Vertical target with N8 size was positioned at 50 cm in front of patient's line of sight. Subject's eye movements were observed for loss of convergence to objectively measure near point of convergence.

Measurement of fusional reserves were done with help of prism which lead to breakdown in fusion. Step vergence method was used. Positive and negative fusional vergences were measured for distance and near.

Accommodative facility was measured with help of ± 1.50Ds flippers. First of all accommodative facility was tested monocularly as well as binocularly number of cycles per minutes were recorded.

Vergence facility was measured with help of 12 ΔBO and 3ΔBI. Number of cycles per minutes were recorded. The normal values were considered according to Morgan's scale. Non strabismic binocular vision anomalies were diagnosed using integrative analysis approach.[3] Data was analysed with help of microsoft excel version 2016. Unpaired t.test was used for analysis and $P< 0.05$ was considered significant.

Study Design: Cross sectional study
Study Location:Nagar School of Optometry, Gujarat University, Ahmedabad, Gujarat
Study Duration: November 2017 to September 2018.
Sample size: 70 patients.

Inclusion criteria:
1. Visual acuity in 6/6 in each eye at 6m distance
2. Near Visual acquity N6 at 40 cm.
3. Absence of manifest squint.
4. Absence of ocular or systemic pathology.
5. Negative history of eye or head trauma.
6. Age more than 18 years or less than 25 years.

Exclusion criteria: (10 Bold)
1. Visual acuity less than 6/6 at 6m distance in either eye.
2. Near Visual acquity less than N6 at 40 cm.
3. Presence of manifest squint.
4. Presence of ocular or systemic pathology.
5. Positive history of eye or head trauma.
6. Age less than 18 years or more than 25 years

Statistical analysis : using Microsoft Excel version 2016.

III. Result

There were 70 participants in the present study. Out of 70 participants, 44 were female and 26 were male. All participants were 18 to 23 years of age. Participants were divided into two groups: symptomatic and asymptomatic -according to the vision quality scale (VQS)3. Out of 70 participants 19 were symptomatic and 51 were asymptomatic. Total Score range of VQS was 43.00 % to 88.88 %. The mean score of vision quality scale in symptomatic subjects was 59.25 ± 21.33 and that of asymptomatic subjects were 77.80 ± 16.64. The independent-sample t-test showed a significant difference in the mean score between the two groups ($p < 0.001$). In symptomatic subjects, range of accommodative lag monocularly as well as binocularly was -1.00 DS to +1.75 DS. Monocularly Mean accommodative lag was 0.33 ± 0.63 and binocularly it was 0.33 ± 0.75. The independent t. test did not show any considerable difference in accommodative lag between monocular and binocular conditions in symptomatic subjects (t .test 0.412). In asymptomatic subjects, range of accommodative lag monocularly was -1.00DS to +1.25 DS while binocularly it was -1.25 DS to +1.00 DS.

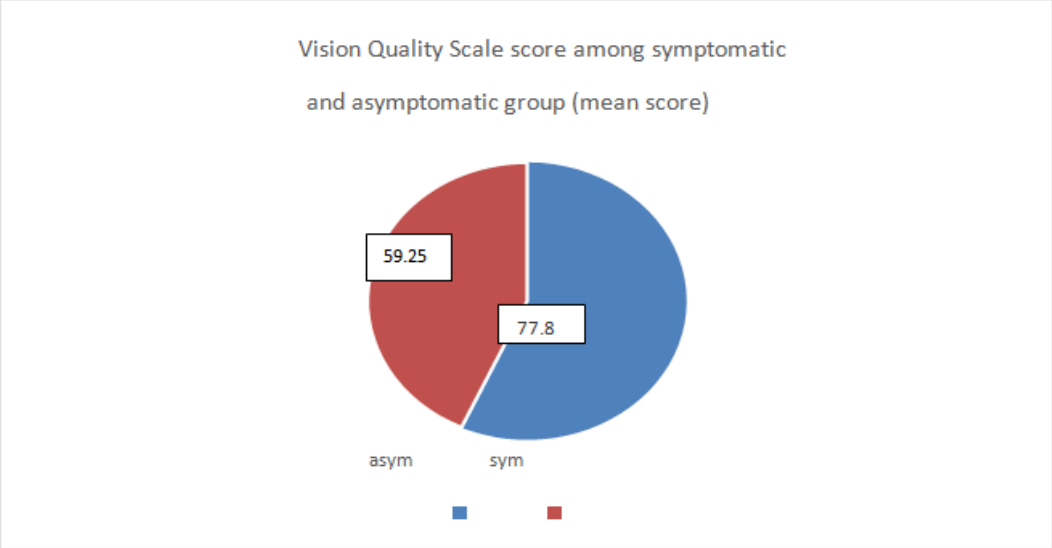

Fig. 1 Sample Polpulation

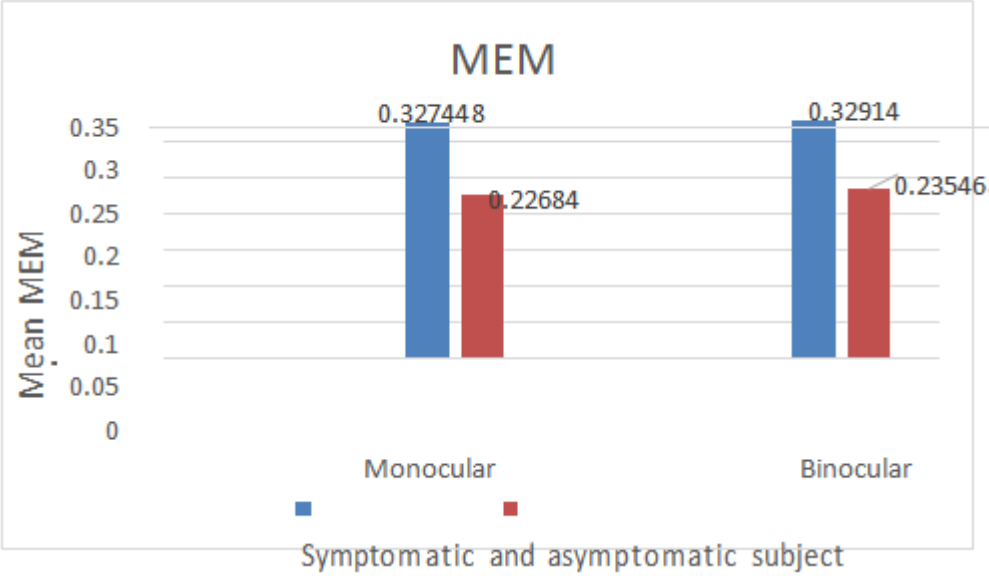

Fig. 2 MEM Retinoscopy

Monocularly the mean accommodative lag was 0.58±0.23 and binocularly it was 0.55±0.24. The independent t. test did not show any significant difference in accommodative lag between monocular and binocular conditions in asymptomatic subjects (t. test 0.58).

Unpaired t.test was performed to compare difference in monocular and binocular accommodative lag between two groups, symptomatic and asymptomatic. There was no significant difference in accommodative lag between the two groups. The t. test comparing binocular lag between symptomatic and asymptomatic participants was 0.016. Standard deviation and mean of distance and near phoria were calculated by considering exophoria as negative and esophoria as positive. In symptomatic subjects distance phoria ranged from -1.00Δ D to +1.00 Δ D and in asymptomatic range of distance phoria was -6.00 Δ D to -8.00 Δ D. The mean distance phoria in symptomatic subjects was 0.157 ± 0.577 and in asymptomatic subjects was 0.23 ± 1.51 .T. test was performed comparing symptomatic and asymptomatic distance phoria 0.832. Range of heterophoria at near in symptomatic subjects was -2.00 Δ D to +0.50 Δ D and range of heterophoria in asymptomatic subjects was -6.00 Δ D to +1.00 Δ D. The mean near phoria in symptomatic subjects was 0.235 ± 1.51 and in asymptomatic subjects it was -0.068 ± 1.124 . t test comparing symptomatic and asymptomatic near phoria was zero.

Out of the sample population of seventy students 1.43% was found to have accommodative spasm, 1.43% were diagnosed with accommodative excess and another 1.43% of students had convergence

insufficiency. 17.14% of the population were found to have poor near point of convergence and rest 78.57% were within normal limits.
Table no. 1 shows summary of results obtained.

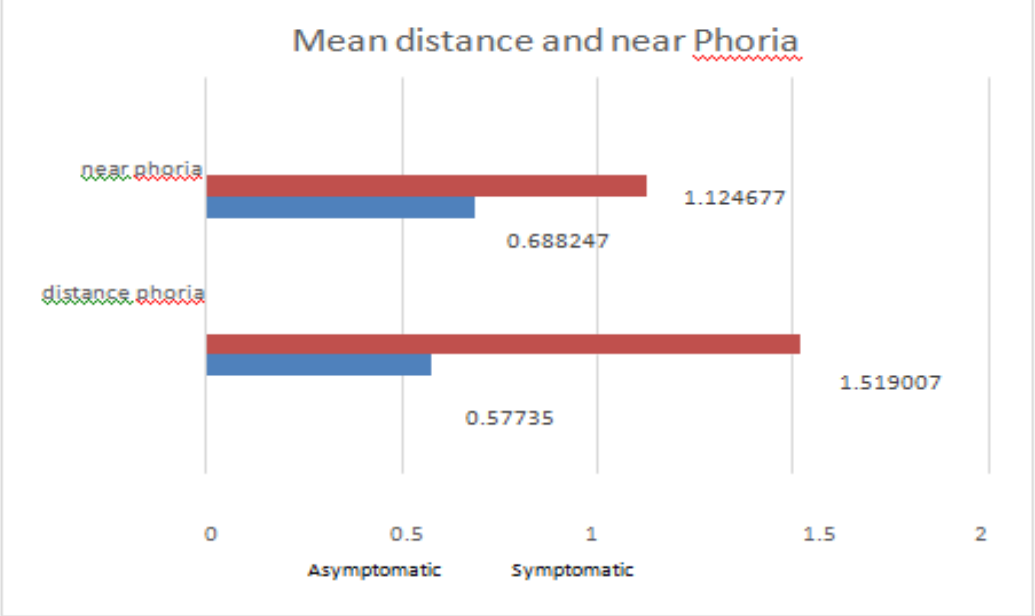

Fig. 3 Mean Phoria

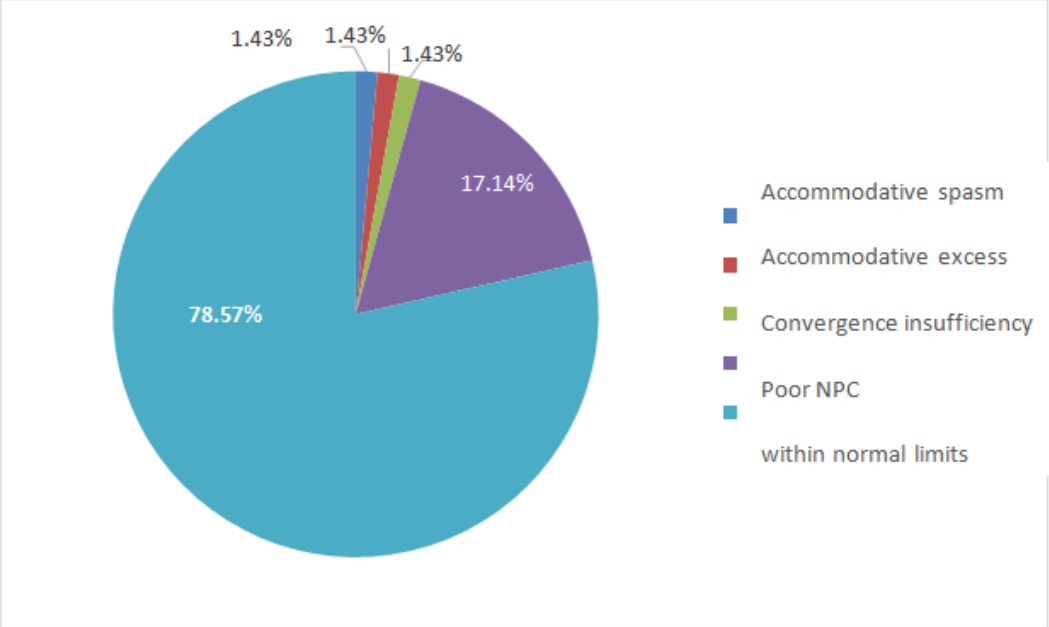

Fig. 4 Results

Procedure	Range	Mean	standard deviation
Age of Symptomatic participants	18 to 23	20.75	± 2.28
Age of Asymptomatic Participants	18 to 23	20	± 0.98.
Total VQS Score	43.00 % to 88.88 %.	65.5%	± 18.50
VQS Symptomatic subjects	72.00% to 88.88%	59.25	± 21.33
VQS Asymptomatic subjects	43.00% to 71.00%	77.80	± 16.64
Accommodative lag monocularly in symptomatic subjects.	-1.00 DS to +1.75 DS	0.33	± 0.63
Acommodative lag binocularly in symptomatic subjects.	-1.00 DS to +1.75 DS	0.33	± 0.75
Accommodative lag monocularly in asymptomatic subjects.	-1.25 DS to +1.00 DS	0.58	±0.23
Accommodative lag binocularly in Asymptomatic subjects.	-1.25 DS to +1.00 DS	0.55	±0.24
Distance phoria in Symptomatic subjects	-1.00Δ D to +1.00 Δ D	0.157	± 0.577
Near phoria in symptomaticsubjects	-2.00 Δ D to +0.50 Δ D	0.235	± 1.51
Distance phoria in asymptomatic subjects.	-6.00 Δ D to -8.00 Δ D.	0.23	± 1.51
Near phoria in asymptomatic subjects.	-6.00 Δ D to +1.00 Δ D.	-0.068	± 1.124

Table no. 1 Summary of Results

IV. Discussion

In the present study 26 male and 44 female participants with age range of 18-23 years were studied. Out of sample population of 70 students, 1.43% were found to have accommodative spasm, 1.43% were diagnosed with accommodative excess and 1.43% of students were diagnosed with convergence insufficiency. 17.14% population were found to have poor NPC and remaining 78.75% had no binocular vision anomalies.

In the study by Moghaddham et.al.[5]) , 70 subjects were evaluated consisting 22 male and 48 female. In the present study also 70 subjects were evaluated and 26 were male and 44 were female thus the sample population was similar in both the cases.

Moghaddham et.al in their study used convergence insufficiency symptom survey questionnaire for differentiation of symptomatic and asymptomatic subjects whereas in the present study Vision quality scale questionnaire was used for classification of symptomatic and asymptomatic subjects. VQS was preferred over CISS as VQS has only 9 questions, it is less time consuming and grading the amount of difficulty (selecting option according to symptoms) was easier for subjects as compared to CISS.

Moghaddham et.al [5] in their study concluded that the near binocular accommodative response was related to near heterophoria. They also found that higher the level of accommodative vergence more was the difference in accommodative lag under monocular and binocular conditions. Whereas in the present study maximum number of participants were orthophoric. No difference in accommodative lag was observed between symptomatic and asymptomatic subjects in monocular and binocular conditions. These might be due to most of the subjects in the present study having lag of accommodation between normal range according to Morgan's Data.

The present study includes university students with age range of 18 to 22 years . The study by Goss and Rainey[6] is on myopic children. It was found that higher lag of accommodation was associated with greater amount of esophoria. It can be assumed that distance and near heterophoria less than 6 PD would not significantly affect accommodative lag. However only accommodative lag related tests are not sufficient for completely studying effect on symptomatic and asymptomatic subjects.

The study by Chilaki Nakatsuka and colleagues[7], discusses wheather or not myopic children have higher lag of accommodation than emmetropic children under habitual seeing conditions. They found that with fully correcting glasses, myopic children showed lower mean lag of accommodation than emmetropic children as well as wide intersubject variation. However when children wore habitual undercorrecting spectacles accommodative lag was markedly reduced. Myopic children with near point exophoria tend to show smaller lags of accommodation. Thus under binocular viewing conditions myopic children when viewing target through fully correcting glasses tend to show larger lags of accommodation than emmetropic children. However lags of accommodation are usually reduced by spectacle under correction.

The current study involving young generation is important in present day context as young people are users of personal computers, mobile phones or laptop for longer duration. Using modern gadgets induces more time spent at near work. It is well known that young people tend to over accommodate when viewing snellen's chart at 6m . This over accommodation is responsible for latent hyperopia or psuedomyopia. Importance of this study is as dynamic retinoscopy. Dynamic retinoscopy is the only objective method to measure accommodative lag ,therefore it should be included in daily practice.

There are other tests apart from accommodative lag which are also necessary to enhance such study. As per study by Hussaindeen et.al, minimum test battery of nearpoint of convergence with penlight and red

green filter, difference between distance and near heterophoria, monocular accommodative facility yield good sensitivity and specificity for diagnosis of non-strabismic binocular vision anomalies[8].

V. Conclusion

In the present study no difference in accommodative lag was observed between symptomatic and asymptomatic subjects in monocular and binocular conditions. Thus series of tests for non strabismic assessment are needed for detecting binocular vision problems and only detecting accommodative lag is not enough.

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Appendix

Name: Date:

Directions : Please circle the number for the response which best represents your answer.

Please provide an answer for each of 9 questions listed.

1) In general, would you say that you have problem with your eyes.
   1) All of the time
   2) Most of the time
   3) Some of the time
   4) A good bit of time
   5) A little of the time
   6) None of the time

2) How would you rate the clearness of vision (with glasses or contact lenses) when doing certain tasks (for example , watching television,movies,driving, reading , writing, or seweing).
   1) Excellent
   2) Very Good
   3) Good
   4) Fair
   5) Poor

3) How often have you had episode of blurred vision and /or double vision during past 4 weeks?
   1) All of the time
   2) Most of the time
   3) Some of the time
   4) A good bit of time
   5) A little of the time
   6) None of the time

4) To what extent do problems with your eyes limit your ability to do certain tasks or the amount of time that you need to do them (for example , because you became tired, lose concentration, or not able to see well enough to complete the tasks.
   1) Excellent
   2) Very Good
   3) Good
   4) Fair
   5) Poor
5) How often do you loose place, re-read the same line, or skip lines when you are reading or copying (for example, when going back to the beginning of the next line, you find yourself on the line just read)?
   1) All of the time
   2) Most of the time
   3) Some of the time
   4) A good bit of time
   5) A little of the time
   6) None of the time

6) To what extent does bright light and/ or dim light affect your ability to do certain tasks?
   1) Extremely
   2) Quite a bit
   3) Moderately
   4) Slightly
   5) Not at all

7) How often have your eyes hurt, watered,burned,or became red or swollen in past 4 weeks?
   1) All of the time.
   2) Most of the time.
   3) A Good of the time.
   4) Some of the time.
   5) A little of the time.
   6) None of the time

8) How often do you had headaches in past 4 weeks?
   1) All of the time.
   2)Most of the time.
   3) A Good of the time.
   4) Some of the time.
   5) A little of the time.
   6) None of the time.

9) To what extent are you embrassed when others notice your eye turn in, out , move independently, or that you are unable to do certain tasks because of your eyes? (if this doesnot apply,circle 6)
   1) Extremely.
   2) Quite a bit.
   3) Moderately.
   4) Slightly.
   5) Not at all.
   6) Does not apply.

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