



Reliability of Monocular Estimation Method and Objective Convergence Test in Assessment of Non Strabismic Binocular Vision Anomalies

Mousumi Saikia¹, Kamal Pant² and Joydeep Dutta^{3*}

¹Department of Optometry and Vision Science, Amity Medical School, Amity University Haryana, Haryana, India

²Department of Optometry, Uttar Pradesh University of Medical Sciences, Uttar Pradesh, India

³Department of Chemistry, Amity School of Applied Sciences, Amity University Haryana, Haryana, India

*Corresponding Author: Joydeep Dutta, Department of Chemistry, Amity School of Applied Sciences, Amity University Haryana, Haryana, India.

DOI: 10.31080/ASOP.2022.05.0532

Received: May 26, 2022

Published: June 06, 2022

© All rights are reserved by Joydeep Dutta, et al.

Abstract

Purpose: To know the reliability of monocular estimation method and objective convergence measurement as an alternative protocol for screening nonstrabismic binocular vision anomalies.

Design: a cross-sectional descriptive observational prospective study.

Methods and Materials: 40 subjects; 26 females and 14 males; mean age (20.31 ± 1.92) were evaluated for accommodative facility and accommodative status with the help of monocular estimation method (dynamic retinoscopy). Objective near point of convergence was assessed with red filter and penlight target. All the tests were done with best corrected visual acuity after refractive error correction. Further these findings were correlated with routine orthoptic work up to know whether these tests alone can be an alternate screening method of nonstrabismic binocular vision anomalies or not.

Results: 27.5% of the subjects were found to have Non Strabismic binocular vision anomalies in relation to conventional routine orthoptic work up showed 32.5% of prevalence. A strong level of agreement (kappa value 0.88) was found, showed statistical significant $p < 0.001$.

Conclusions: Objective assessment of accommodative facility, status of accommodation and near point of convergence can be alternative protocol for screening nonstrabismic binocular vision anomalies in community set up.

Keywords: Accommodative Facility; Status of Accommodation; Non strabismic Binocular Vision Anomalies; Accommodative and Vergence Anomalies; Monocular Estimation Method

Abbreviations

NSBVA: Non Strabismic Binocular Vision Anomalies; AF: Accommodative Facility; AC/A: Accommodative Convergence and Accommodation Ratio; MEM: Monocular Estimation Method; NPC: Near Point of Convergence

Introduction

Recent studies report a high prevalence of binocular dysfunction among university students, ranging between 32.3–42% [1,2]. Looking at the huge population of India and the prevalence of binocular vision anomalies is about 30-34%, intervention in

this area is an alarming factor. Non-strabismic binocular vision anomalies (NSBVA) are considered as vision anomalies which affect clarity, binocularity, impair the comfort and effectiveness of visual performance when near work (Reading, Writing and Computer-based work) is performed [3]. Asthenopia can be a significant handicap to learning, which not only lead to deficient visual performance, but also poor academic progress due to the anomalies. Symptoms commonly associated with accommodative and vergence anomalies include blurred vision, headache, ocular discomfort, ocular or systemic fatigue, diplopia, motion sickness, and loss of concentration during a task performance. However, these symptoms that the patient perceives may differ depending on the type of causative disorder [4]. To get the diagnosis, visual processing system evaluation (visual skill and perceptual skill) is very much important. A detailed orthoptic examination requires lots of instrumentation and human resources. This clinical sign-based investigation; comprehensive binocular vision assessment (vision efficiency skills) is generally a time consuming detail evaluation which is mainly subjective based and takes about 45minutes. There are no minimum objective tests available to screen the presence of binocular vision anomalies. Monocular estimation method emphasizes the importance of objective evaluation of accommodative facility in one study [5]. So a rapid assessment tool with monocular estimation method can be a solution which is cheap, easy, less time consuming. Our aim of the study was to do a quick assessment of nonstrabismic binocular vision anomalies with monocular estimation method and objective near point of convergence (NPC).

Materials and Methods

Subjects of age group between 18 years to 25 years with best corrected distance visual acuity of at least 6/6 (20/20) monocularly and near visual acuity of N6 at 33cm were included in the study. Insignificant uncorrected refractive error, healthy eyes, and no strabismic or amblyopic were included. This study adhered to the tenets of Declaration of Helsinki and was approved by Institutional Ethical Board of Amity University, Haryana.

We conducted a cross-sectional observational prospective study of 40 subjects where 26 female and 14 male; mean age (20.31 ± 1.92). Accommodative facility (AF) and accommodative status, both with monocular estimation method was measured in all subjects followed by measuring near point of accommodation

objectively. Before assessing the accommodative facility, as a part of the experimental protocol, patient personal details and consent were recorded. Each subject was asked about his or her chief visual complaints, medical and ocular history, medications, and hypersensitivities. Visual acuity both distance and near along with objective and subjective refraction for best corrected visual acuity was performed. General slit lamp examination was done for anterior and posterior segment assessment. Subjects with abnormal facility and status of accommodation were further evaluated with detailed orthoptic workup to confirm the diagnosis. To detect and properly diagnose nonstrabismic accommodative and vergence anomalies, it is important to have a comprehensive package of accommodation and vergence tests as well as a systematic method for the analysis of accommodation and vergence findings. Preliminary orthoptic tests included cover test along with phoria measurement at near and at distance, near point of convergence, ocular motility, fusion (Worth 4-dot test) and stereopsis (titmus fly). Next AC/A ratio (accommodative convergence/ accommodation) was obtained with the gradient method, lateral and vertical fusional vergence at near and at distance (step vergence testing), vergence facility testing (12 prism diopters base-out and 3 prism diopters base-in), negative and positive relative accommodation, monocular and binocular accommodative facility (flippers with ± 2.00-diopter lenses), monocular estimation method (MEM), and amplitude of accommodation using the push-up with RAF ruler were measured.

For assessment of accommodative facility with MEM retinoscopy, we followed the methodology used by Gallaway M., *et al.* [5]. According to their procedure, measurement of relative accommodation (positive and negative) was performed as the prerequisite for the objective measurement of accommodative facility.

Accommodative status represents the individual's lag or lead of accommodation to the near working distance stimulus and quantitative value of the finding is measured in positive or negative lenses with the help of dynamic retinoscopy.

Near point of convergence (NPC) was measured with a red filter placed in front of one eye and by moving the penlight target closer to the eye until the subject's eye deviated or we observed fusion break. Then the value was recorded in centimetre.

Among the tests i.e. relative accommodation, accommodative facility, accommodative status and near point of convergence, if abnormal findings were observed between any of these two tests has been considered as binocular vision anomalies in this study. Then the conventional orthoptic assessment was done to confirm and the diagnosis of NSBVAs was made based on the protocol suggested by Scheiman and Wick [4].

The data were entered into the Excel sheet and analyzed using the Statistical Package for the Social Sciences version 20.0 (SPSS Inc, Chicago, IL, USA). The data were expressed as proportions (n, %).

Results

Prevalence of non strabismic binocular vision anomalies were found 27.5% with the objective assessments and 72.5% was found as having normal findings among 40 subjects. Figure 1 shows the graphical presentation of the prevalence data with our assessment method. Figure 2 shows the graphical presentation of prevalence data from the conventional orthoptic work up. The conventional orthoptic evaluation was performed with the same 40 subjects and the prevalence of NSBVA was found as 32.5%.

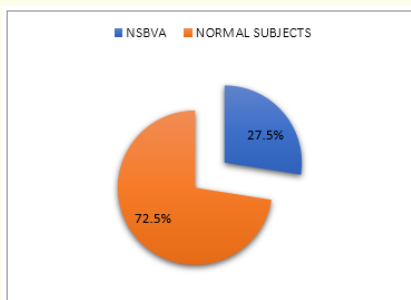


Figure 1: Monocular estimation method and NPC result (prevalence).

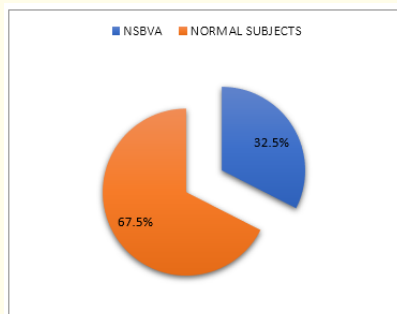


Figure 2: Conventional orthoptic method result (prevalence).

Diagnosis of NSBVA with monocular estimation method (facility and status) showed a strong level of agreement (kappa value 0.88) which is statistical significant $p < 0.001$ (Table 1 and 2).

Negative		Conventional method		Total
		Positive		
Mem method	Negative	27	2	29
	Positive	0	11	11
Total		27	13	40

Table 1: Monocular estimation method. * Conventional method Crosstabulation.

		Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Measure of Agreement	Kappa	.881	.081	5.614	.000
N of Valid Cases		40			

Table 2: Symmetric Measures.

- a. Not assuming the null hypothesis.
- b. Using the asymptotic standard error assuming the null hypothesis.

Table 3 and 4 shows the test item mean and standard deviation. Table 5-8 shows inter-test item correlation results.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.794	.794	4

Table 3: Reliability Statistics.

	Mean	Std. Deviation	N
Relative accommodation	.28	.452	40
Accommodative status	.28	.452	40
Accommodative facility	.30	.464	40
Near point of convergence	.13	.335	40

Table 4: Item Statistics.

	Relative accommodation	Accommodative status	Accommodative facility	Near point of convergence
Relative accommodation	1.000	.498	.452	.275
Accommodative status	.498	1.000	.696	.614
Accommodative facility	.452	.696	1.000	.412
Near point of convergence	.275	.614	.412	1.000

Table 5: Inter-Item Correlation Matrix.

	Mean	Minimum	Maximum	Range	Maximum/Minimum	Variance	N of Items
Inter-Item Correlations	.491	.275	.696	.421	2.531	.020	4

Table 6: Summary Item Statistics.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Relative accommodation	.70	1.138	.494	.271	.799
Accommodative status	.70	.933	.781	.642	.645
Accommodative facility	.68	.994	.659	.500	.714
Near point of convergence	.85	1.310	.518	.378	.785

Table 7: Item-Total Statistics.

Mean	Variance	Std. Deviation	N of Items
.98	1.820	1.349	4

Table 8: Scale Statistics.

Reliability index of the tests measurement were also measured with internal consistency between items i.e. relative accommodation, facility of accommodation, status of accommodation and near point of convergence. A good level of agreement between these items were found, where all Cronbach's Alpha value were between 0.65-0.80.

Discussion

The findings of the result indicates the importance of orthoptic evaluation of each and every asymptomatic healthy individual young adult as these binocular dysfunctions are significantly associated with impaired academic performance. Though the principal symptom of our study was asthenopia, but maximum subjects were asymptomatic. In recent years, many researchers

have reported about clinical significance of testing accommodative response (status) and facility in young adult group population [6,7]. A relation between less accommodative facility and a general binocular dysfunction (accommodative or binocular) were found in 48 subjects, aged 10-30 (those were pre-diagnosed), which demonstrated the importance of the accommodative facility test in diagnosing an accommodative or binocular anomaly [8]. All the above mentioned studies used the conventional method of measurement to assess the facility of accommodation. The conventional orthoptic evaluation procedures to diagnose anomalies are maximum subjective based and time consuming. Gallaway M [5]. validated the monocular estimation method for assessment of accommodative facility where they found the same test effectively as conventional subjective facility test. Hussaindeen., *et al.* [9]. evaluated the anomalies with three minimum tests and recommended to use these test as screening test in a community set-up. Hussaindeen screened 305 children (age 12.7 ± 2) with near point of convergence (penlight and red filter), difference

between distance and near phoria, and monocular accommodative facility test (subjective) to know the prevalence of nonstrabismic anomalies. The prevalence of NSBVAs was found to be 26 per cent, yield good sensitivity and specificity for diagnosis

Our results showed a prevalence of 27.5% NSBVA in relation to 32.5% from conventional method. Though prevalence value has minimum differences, yet it can be an alternate method of quick screening of binocular vision anomalies. As it is a single instrument based (only retinoscope) assessment technique, a larger number of subjects can be screened in a less time duration.

Limitation

As the sample size evaluated in our study were less, more studies with large sample size are required.

Conclusion

Objective assessment of accommodative facility, status of accommodation and near point of convergence can be alternative protocol for screening nonstrabismic binocular vision anomalies in community set up.

Acknowledgements

We are also thankful to the subjects for their participation.

Conflict of Interest

Nil.

Bibliography

1. Porcar E and A Martinez-Palomera. "Prevalence of general binocular dysfunctions in a population of university students". *Optometry and Vision Science : Official Publication of the American Academy of Optometry* 74.2 (1997): 111-113.
2. Richman J and Laudon R. "The incidence of binocular dysfunction in optometry students enrolled in a course for binocular vision disorders". *Optometry and Vision Science* 78(2001):157.
3. Cacho-Martínez Pilar, *et al.* "Is there any evidence for the validity of diagnostic criteria used for accommodative and nonstrabismic binocular dysfunctions?". *Journal of Optometry* 7.1 (2014): 2-21.
4. Scheiman M and Wick B. "Clinical management of binocular vision: heterophoric, accommodative, and eye movement disorders". Philadelphia, PA: Lippincott Williams and Wilkins; (2008).
5. Gallaway M and M Scheiman. "Assessment of accommodative facility using MEM retinoscopy". *Journal of the American Optometric Association* 61.1 (1990): 36-39.
6. Scheiman M., *et al.* "Normative study of accommodative facility in elementary schoolchildren". *American Journal of Optometry and Physiological Optics* 65.2 (1988): 127-134.
7. Levine S., *et al.* "Clinical assessment of accommodative facility in symptomatic and asymptomatic individuals". *Journal of the American Optometric Association* 56.4 (1985): 286-290.
8. Garcia A., *et al.* "The relation between accommodative facility and general binocular dysfunction". *Ophthalmic and Physiological Optics : The Journal of the British College of Ophthalmic Opticians (Optometrists)* 20.2 (2000): 98-104.
9. Hussaindeen Jameel Rizwana, *et al.* "The minimum test battery to screen for binocular vision anomalies: report 3 of the BAND study". *Clinical and Experimental Optometry* 101.2 (2018): 281-287.