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Comparison of Stereopsis, Contrast Sensitivity and Near Points of Accommodation In Patients With Degree of Myopia

Sachitanand Singh[1], **Renu Thakur**[2*], **Diksha Kumari**[3], **Prachi Yadav**[4] **and Bipina Gautam**[5]

[1,2,3]*Chitkara School of Health Sciences, Chitkara University, Punjab, India*
[4,5]*Rajiv Gandhi University of Health Sciences, Bangalore, Karnataka, India*

[*]renu.thakur@chitkara.edu.in (Corresponding Author)

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ABSTRACT

Background: Stereopsis is the ability to perceive depth in objects through binocular vision, where the brain interprets 2-dimensional retinal images as 3-dimensional shadows. It plays a crucial role in assessing and understanding the objects we see. Factors like sensory and motor fusion greatly influence the quality of stereoscopic vision. Myopia, a condition characterized by near-sightedness, can negatively impact stereopsis. Contrast sensitivity refers to the ability to discern sharp outlines and detect subtle differences in shading and patterns. It helps identify objects with unclear boundaries against their background.

Purpose: This study aimed to compare Stereopsis, Contrast Sensitivity, and Near Point of Accommodation among individuals with different grades of Myopia and Emmetropia.

Methods: A cross-sectional comparative study was conducted at Nandadeep Eye Hospital, Maharastra, involving staff and patients aged 15 to 30 years. Participants with strabismus, anisometropia, previous ocular surgery, ocular diseases, or systemic conditions were excluded. The assessments included objective and subjective refraction eye examinations, as well as measurements of stereopsis, contrast sensitivity, and near point of accommodation.

Results: The results, based on 109 subjects, indicated no significant change in contrast sensitivity between emmetropes and myopes. However, there were significant differences in stereoacuity and NPA among different grades of myopes compared to emmetropes.

Conclusions: the study suggests that optometrists and eye healthcare professionals should assess stereopsis and near point of accommodation in severely myopic patients even after optical correction, and consider vision therapy if necessary, as it is an effective treatment for accommodative and binocular vision anomalies.

1. Introduction

When accommodation is completely at rest, emmetropia, also known as the optical normal eye, is a state of refraction in which parallel light rays from infinity are focused in the retina to provide emmetropia with a clear image of a distant object without the need for any internal optics adjustment (Khurana *et al.*, 2014). Myopia commonly referred to as short-sightedness, which is designated with a minus sign in which mild myopia (0.5 to 1.5), moderate myopia (1.5 to 6.00D) and severe (more than -6.00) were classified (Chanchal *et al.*, 2017). Stereopsis is the process by which two-dimensional shadows cast on the retina are converted into three-dimensional shadows when an object is perceived with good binocular vision in both eyes. It is the third grades of binocular vision. Good stereoscopic vision is highly valuable for assessing and comprehending the objects we see. The main contributors to achieving this are good sensory fusion and motor fusion. Myopia is a factor that can lead to reduced stereoscopic vision (Saputra *et al.*, 2018). Impaired stereoscopic vision, also known as the highest level of binocular vision, is typically developed in early life and necessitates simultaneous perception of each eye's input and the 'fusion' of these two images during brain development (Kuang *et al.*, 2005) This type of vision plays a crucial role in daily activities, and its deficiency can hinder a person's normal functioning (Schieman and Wick, 2008). The reduction of stereopsis due to refractive errors makes stereopsis tests useful for screening myopic individuals. Since stereopsis relies on binocular vision, any factor that disrupts binocular vision can also impact stereopsis. Therefore, evaluating stereopsis in these individuals becomes essential (Ahmadi *et al.*, 2018). The stereopsis test is considered

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the most effective method for diagnosing binocular visual impairment. The normal range for stereopsis is 40-60 seconds of arc (Waugh and Grant, 2014). Binocular single vision occurs when a person focuses their visual attention on an object, forming separate images on the fovea of each eye but perceiving them as a single image. Stereoacuity refers to the smallest amount of horizontal retinal image disparity that leads to the perception of relative depth or stereopsis. Various ocular conditions, such as ametropia, aniseikonia, amblyopia, strabismus, nystagmus, aphakia, mono vision, and mono fixation syndrome, can influence the development of stereopsis (Jindra and Zemon, 1989). The capacity to perceive, differentiate, or identify objects that have moderate differences in relative luminance is known as contrast sensitivity. Variations in retinal ganglion cells' sensitivity account for differences in contrast sensitivity. The eye can understand an object by comparing the variations in light levels between the target and the background. Measuring contrast sensitivity is valuable in assessing vision quality. Image quality on the retina may suffer degradation due to optical aberrations and light scattering, resulting in a decline in subjective visual performance. Therefore, contrast sensitivity is clinically beneficial for detecting subtle changes in subjective visual performance. It plays a fundamental role in visual performance and enables tasks such as driving, reading, navigation, and other binocular activities, with contrast sensitivity measurements providing an indication of the quality of vision (Sukha and Rubin, 2013).

2. Materials & Methods

The research design was cross sectional comparative study with random sampling. The participants were all the staff and patients from Nandadeep Eye Hospital, Sangli, and Maharashtra. Random sampling was done. The total number of samples was 109 in which 56 were emmetropes and 53 were myopes[1] (Kothari, 2004). The trial lasted from February 2020 to September 2021. Vision charts, Log MAR for distance and reduced Snellen for near vision, Chart for stereopsis, Pelli Robson Contrast Sensitivity Chart, trial frame, Retinoscope, Slitlamp, Adaptable target, RAF, Ruler, N8 Linear Vertical target, were utilised in this investigation (Garcia-Munoz *et al.*, 2014). Stereoacuity, contrast sensitivity and NPA is very important for vision and literature suggest there are changes in this all in different refractive condition, very few study was conducted in this topic and specially in myopia and in different grades of myopia so fulfil this gap this current study was conducted. The primary objectives of the study were: to ascertain the Stereopsis in various grades of myopia, to investigate the contrast sensitivity in different grades of myopia, to identify the near point of accommodation in different grades of myopia, to compare the variables (Stereopsis, contrast sensitivity, near point of accommodation) between different grades of myopia and emmetropia. The inclusion criteria were emmetropes ($\leq \pm$ 0.25D) with the best corrected visual acuity of 6/6. Patients between 15-30 years of age. The exclusion criteria were Patients having strabismus, Anisometropia, any kind ophthalmic surgery, ocular diseases, and any H/O systemic diseases (Leat *et al.*, 2013). Before enrolling the staff and patients of Nandadeep in the study, permission was taken from the hospital authorities to conduct the study. All subjects were informed about the purpose and procedure of the study, and written consent was obtained from each subject before enrolling them. Only those who met the inclusion criteria were selected for the study. The examination process began by gathering the subjects' history and demographic data. Subsequently, their visual acuity for distance and near vision was assessed, followed by objective refraction. The subjects' phoria/tropia were evaluated using a cover test, and a general eye examination was conducted using a slit lamp. Finally, the subjects underwent tests for stereopsis, contrast sensitivity, and near point of accommodation (Duane, 1922).

3. Results

For all statistical analyses, IBM SPSS statistics 20 (IBM corporation, USA) is utilized. The significance level is tested using non-parametric tests since the Shappiro-Wilk test indicated that the data were not regularly distributed. Wallis, Kruskal The test measures variations in a number of metrics (CS, NPA, and Stereoacuity) throughout a variety of refractive errors and myopia grades. The Mann-Whitney U test is used to determine whether emmetropes and myopes vary in any way. The median is used to represent the data (quartile 1, quartile 3). The significance level is indicated by a P value <0.05. Table 1 displays the participants' demographic information for various criteria. All subjects' near visual acuity was N6 in both the uncorrected and corrected images of RE and LE.

Table 1: Demographic details of participants in overall, emmetropes and myopes.

Parameters	Overall	Emmetropes	Myopes
Age	21.94±4.27	22.55±3.25	21.30±5.10
Gender (Male:Female)	65:44	33:23	32:21

UCVA RE (log MAR)	0.28±0.39	0.00±0.00	0.57±0.39
UCVA LE (log MAR)	0.45±1.93	0.00±0.00	0.93±2.70
BCVA RE (log MAR)	0.00±0.00	0.00±0.00	0.00±0.00
BCVA LE (log MAR)	0.00±0.00	0.00±0.00	0.00±0.00
SER RE (D)	−1.19±2.11	0.00±0.00	−2.45±2.47
SER LE (D)	−1.64±5.05	0.00±0.00	−3.37±6.86

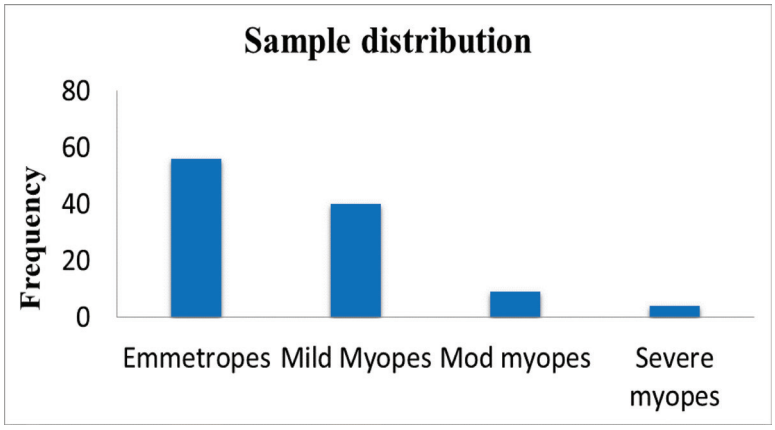

Figure 1: Bar diagram of population distribution in Emmetrope and grades of Myopia.

Table 2: displays the median value of various measured parameters for emmetropes and myopia. To compare the differences between emmetropes and myopes, the P-value was calculated using the Mann-Whitney U-test.

Contrast sensitivity (log units) OS OU		OD	2.25	1.95	0.43
			2.25	1.95	0.43
			2.25	2.25	0.70
NPA (cm)	BLUR	OD	10	8	<0.01
		OS	10	8	<0.01
		OU	9	7	<0.01
	RECOVERY	OD	12	10	<0.01
		OS	12	10	<0.01
		OU	11	9	<0.01
Stereo acuity (sec of arc)		OU	32	63	<0.01

Table 3: presents the median value for various parameters measured across different grades of myopia. To assess the distinctions between these grades of myopia, we used the Kruskal-Wallis test to calculate an overall P-value. Additionally, we employed the Mann-Whitney U-test to determine the individual P-value, comparing the data of emmetropes with that of various grades of myopes.

Parameter	Eye	Emmetrope (median)	Mild myopes (median)	p-value(emm vs mild)	Moderate myopes (median)	P-value (emm vs mod)	Severe myopes (median)	P-value (emm vs severe)	Overall P value
Contrast sensitivity	OD	2.25	2.25	0.8	2.10	0.7	2.03	0.6	0.94
	OS	2.25	2.10	0.7	2.10	0.7	2.03	0.6	0.73
	OU	2.25	2.25	0.8	2.25	0.8	2.25	0.8	0.57
NPA blur(cm)	OD	10	8	<0.01	6	<0.01	6	<0.01	<0.01
	OS	10	9	<0.01	6	<0.01	6	<0.01	<0.01
	OU	9	8	<0.01	6	<0.01	6	<0.01	<0.01
NPA Recovery(cm)	OD	12	10	<0.01	8	<0.01	8	<0.01	<0.01
	OS	12	10	<0.01	8	<0.01	8	<0.01	<0.01
	OU	11	10	<0.01	8	<0.01	8	<0.01	<0.01
Stereo acuity (sec of arc)	OU	32	56	<0.01	60	<0.01	160	<0.01	<0.01

4. Discussion

According to a study by Saputra *et al.* "Relationship between degree of myopia and streoscopic vision in high school children". The study's findings indicated that there are variations in stereoscopic vision among patients with mild, moderate, and severe myopia. Furthermore, a correlation was observed between the degree of myopia and the decline in stereoscopic vision, with a significance value of p=0.001.The result was founded that there is a relationship between myopia and stereoscopic vision with significant difference in stereopsis with each grades of myopia. In current study also states that there is relationship between grades of myopia and stereoscopic vision with significant difference of ($p<0.01$) (Rehmat *et al.*, 2023). Bistra *et al.* conducted a study investigating the correlation between the degree of myopia and foveal measured contrast thresholds. The study revealed that myopia, the type of contrast, and the level of background luminance all have an impact on contrast thresholds. Notably, even after refractive errors were corrected, myopic individuals exhibited reduced contrast sensitivity, as indicated by the study's findings (Vera-Diaz, *et al.*, 2018). Liou *et al.* did a study on "Myopia and contrast sensitivity function**"** found that in mild and moderate grades of myopia, no statically significant difference was found but in severe myopia statically loss of contrast was found while the present study shows that in mild, moderate and also severe myopia was no statically significant difference (Stoimenova, 2007). In their study titled "A dynamic relationship between myopia and blur-driven accommodation in school-aged children," Wiazda *et al.* discovered a strong correlation between changes in refractive error and accommodation function over 6-12 month periods in myopic individuals, but not in emmetropic individuals. This finding is significant and relevant to the current research (Liou and Chiu, 2001). Gwiazda *et al.* conducted a study on "Myopic children demonstrating an insufficient accommodative response to blur" and found that myopic children exhibit greater accommodation than emmetropic children when focusing on real targets at close distances. The current study also confirms that myopic individuals accommodate more than those with emmetropic eyes (Gwiazda *et al.*, 1993; Gwiazda *et al.*, 1995).

Conclusion

The study concluded that total participants were 109, out of which 56 were emmetropes, 40 were mild myopes, 9 were moderate myopes and 4 were severe myopes with average age 21.94 ±4.27. From present study states that there is no change in contrast compared to emmetrope and myopes while it shows there statically significant difference in the stereoacuity and NPA with in the different

grade of myopes compared to the emmetrope. As the myopia power increases stereoacuity and NPA decreases There is a study needed to conduct on management option for severe myopic patients to get optimal Stereopsis and Near Point of accommodation.

Competing Interests

The authors declare that no competing interests exist

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Chitkara University, Saraswati Kendra, SCO 160-161, Sector 9-C, Chandigarh, 160009, India

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