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Original Article

Ophthalmology Section

Clinical Profile of Non Strabismic Binocular Vision Anomalies in MBBS and Nursing Students in a Teaching Hospital: A Cross-sectional Study

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ABSTRACT

Introduction: Bachelor of Medicine and Bachelor of Surgery (MBBS) and nursing students spend a lot of time in near vision activities daily while studying. In the Coronavirus Disease-2019 (COVID-19) and post pandemic era, the emphasis on electronic teaching and studying has increased immensely. Students have started depending more on online studying, teaching and search for study material leading to more time being spent using electronic devices like mobile phones, tabs, Personal Computer (PC), etc. This can lead to lot of eye strain (digital eye strain) and this predisposes them to develop Non Strabismic Binocular Vision Anomalies (NSBVA) related to accommodation and convergence of eyes.

Aim: To study prevalence of NSBVA and report associated ocular symptoms and association of electronic devices (mobile, laptop) use with prevalence NSBVA, in MBBS and nursing students of a teaching hospital in Western Maharashtra.

Materials and Methods: This study was a cross-sectional observational study conducted between November 2020 to April 2021 at Rajiv Gandhi Medical College and CSM Hospital, Thane, Maharashtra, India. In this study, a total of 110 students including both MBBS and nursing students from all academic years of the hospital were examined for a comprehensive ophthalmic examination and complete binocular vision assessment. The prevalence of NSBVA, associated ocular symptoms, prevalence of refractive errors and duration of electronic device use in the students was documented. Student's t-test was used to compare the total daily duration of electronic devices (mobile, laptop, computer tablets) use between students with and without NSBVA. Chi-square test was used to find association of variables duration of electronic device use and occurrence of NSBVA.

Results: Out of 110 students examined, there were 37.27% (n=41) were males and 62.72% (n=69) females. Age range was 18-30 years with mean age 21.85±2.67 years. Overall, 47 (42.72%) students had NSBVA including 34 MBBS and 13 nursing students. 12 (11%) students had ocular symptoms with NSBVA while 35 (31.8%) students had NSBVA without any ocular symptom. Eye strain was the most common ocular symptom. Average electronic device use was 4.53 hours/day. Most used electronic device was mobile phone. There was no association between NSBVA and electronic device use.

Conclusion: The NSBVA is highly prevalent among MBBS and nursing students. Ocular symptoms are absent in many students with NSBVA which may lead to delayed diagnosis and worsening of ocular symptoms due to NSBVA. Older age group of students have higher prevalence of NSBVA. Electronic device exposure is not significantly associated with NSBVA in these students. Screening of such at risk population is important for timely diagnosis and treatment of NSBVA.

Keywords: Accommodation excess, Convergence insufficiency, Electronic device, Eye strain

INTRODUCTION

When we read and change fixation to near vision task, our eyes converge i.e., move inward and the focusing power of eyes increases i.e., eyes accommodate. Both these convergence and accommodation mechanisms should work harmoniously together for carrying out near and distant tasks. An imbalance between these mechanisms leads to a group of disorders clubbed under category of Non Strabismic Binocular Vision Anomalies (NSBVA) [1]. NSBVA can be accompanied by symptoms like eye strain, headache, blurry vision and inability to focus on near objects, making it difficult for individuals to perform daily tasks [2,3]. These anomalies maybe asymptomatic but if left untreated or undiagnosed for long time, they can deteriorate into manifest strabismus.

In recent times, emphasis on near tasks like reading, desk work and use of electronic devices like computers, mobiles, has increased immensely. This can put undue stress on accommodation and vergence mechanisms of eyes, increasing risk of NSBVA. A high percentage of computer users are reported to have binocular vision problems which can worsen with prolonged computer use [4].

In COVID-19 pandemic times, students from all academic fields have relied more on use of devices like smart phones, computers, computer tablets for studying, attending lectures and internet surfing. Medical and nursing students are more likely to be exposed to such prolonged near tasks and use of such devices, exposing them to risk of developing NSBVA. Few studies on NSBVA in college students and school children have been conducted in past. To best of our knowledge, NSBVA in medical and nursing students and its association with electronic device exposure among them have not been studied. With this aim, the current study was conducted to know more about NSBVA in such at-risk group of student population.

Thus, the objectives of the present study were:

1. To find out prevalence of NSBVA and various ocular symptoms in MBBS and Nursing students of a teaching hospital.
2. To find association between use of electronic devices like mobile phones and laptops with occurrence of NSBVA in these students.

MATERIALS AND METHODS

This cross-sectional study was conducted from November 2020 to April 2021 at Rajiv Gandhi Medical College and CSM Hospital,

Thane. The Ethical Clearance from the Institutional Review Board and Ethics Committee of the hospital (RGMC/CSMH/IEC/A/392/2020).

The study adhered to the Tenets of Declaration of Helsinki. The MBBS and nursing students of the hospital willing to participate in the study were examined in Ophthalmology Outpatient Department after obtaining written informed consent.

Sample size calculation: Considering the average prevalence of binocular dysfunction to be 33% from the study by Porcar E [5], and precision/absolute error of 9%, sample size was estimated to be 104 by using Cochran formula [5].

Inclusion criteria: All MBBS and nursing students who were willing to participate in the study were included in the study.

Exclusion criteria: Students with manifest squint or history of squint surgery, any intraocular diseases, students with history of any other intraocular surgeries like cataract surgery were excluded from the study.

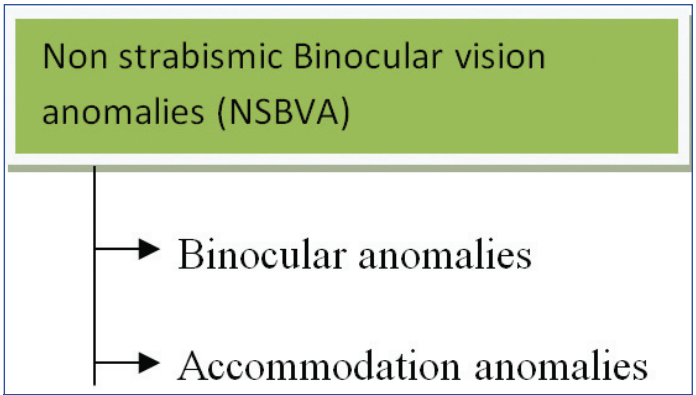
Study Procedure

The students were subjected to detailed history taking about any asthenopic symptoms like headache, eye strain, blurring of vision, watering of eyes while reading/ studying and while using electronic devices like mobile phones, computers. Students were also asked in detail regarding the number of hours of use of devices like mobile phones, laptop, computer tablets per day and duration of regular use. Following this, all students underwent a comprehensive ophthalmic evaluation (including visual acuity, cycloplegic refraction, anterior segment examination of eyes of slit lamp and fundus examination) and binocular vision assessment by a single observer (RT). Binocular vision assessment was done with best corrected glasses if any.

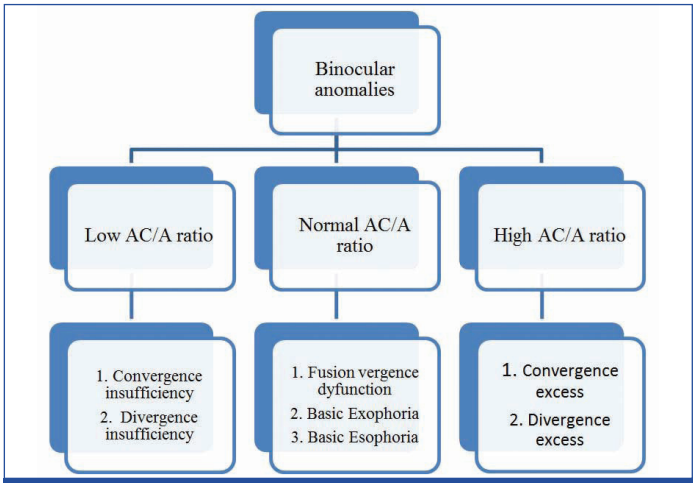
Following parameters were assessed for binocular vision assessment [6]:

1. Worth four dot test for distance and near
2. Phoria for near (at 40 cm) and distance at (6 meters) was measured with a prism bar
3. Accommodative Convergence: Accommodation (AC/A) ratio was measured by lens gradient method.
4. Near point of accommodation (NPA) and Near Point of Convergence (NPC). Average of three readings measured with Royal Air Force (RAF) rule [7].
5. Negative Fusional Vergence (NFV) and Positive Fusional Vergence (PFV) for near (at 40 cm) was measured was using prism bar by sequentially increasing strength of base-in and base-out prism and noting point of first blur and recovery.
6. Negative Relative Accommodation (NRA) and Positive Relative Accommodation (PRA) was measured as first sustained blur after sequentially increasing strength of positive and negative lenses.
7. Accommodation Facility Testing (AF) was done using standard accommodation rock cards and ±2 diopter accommodation flipper lenses both binocularly and uniocularly.
8. Monocular Estimation Method (MEM) retinoscopy was done using MEM card and streak retinoscope at 40 cm distance for assessing accommodation response.

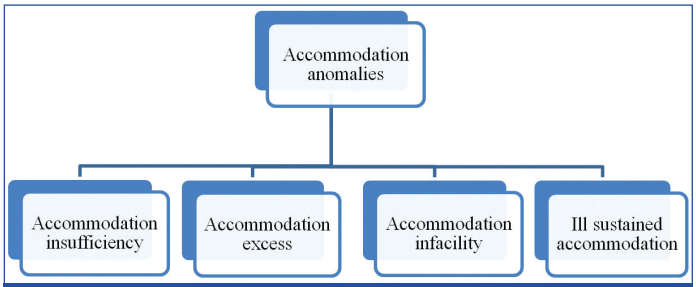
The NSBVA anomalies include two types binocular anomalies and accommodation anomalies [Table/Fig-1-3] [6]. Salient features of accommodation anomalies and binocular anomalies are presented in [Table/Fig-4,5] [6].



[Table/Fig-1]: NSBVA anomalies [6].



[Table/Fig-2]: Binocular anomalies [6].



[Table/Fig-3]: Accommodation anomalies [6].

Anomaly	Main signs
Accommodation insufficiency	Low Accommodation Amplitude (AA)
	Low Positive Relative Accommodation (PRA)
	Fails flipper test with minus lenses (both uniocular and binocular)
	High MEM retinoscopy finding
	Low base-out to blur at near
Accommodation excess	Low Negative Relative Accommodation (NRA)
	Fails flipper test with plus lenses (both uniocular and binocular)
	Low MEM retinoscopy finding
	Low base-in to blur at near
Accommodation infacility	Low NRA and PRA Difficulty with both plus and minus lenses on facility test

[Table/Fig-4]: Salient features of accommodation anomalies [6].

STATISTICAL ANALYSIS

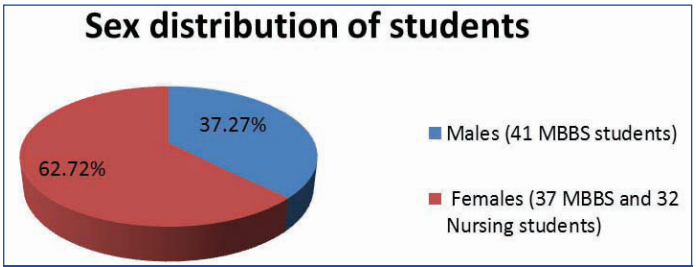
The statistical analysis was done using the Statistical Package for Social Sciences (SPSS) software version 2022. Student's t-test was used to compare the total daily duration of electronic devices (mobile, laptop, computer tablets) use between students with and without NSBVA. Chi-square test was used to find association of variable duration of electronic device use and occurrence of NSBVA. p-value <0.05 was considered statistically significant.

RESULTS

A total of 110 students were examined which included 78 MBBS and 32 nursing students. Age of the students examined ranged from 18-30 years with mean age 21.85±2.67 years. Age of MBBS students examined ranged between 19-30 years age whereas nursing students ranged between 18-22 years age. There were 41 males (all MBBS students) and 69 females (including 37 MBBS and 32 nursing students) in the present study [Table/Fig-6].

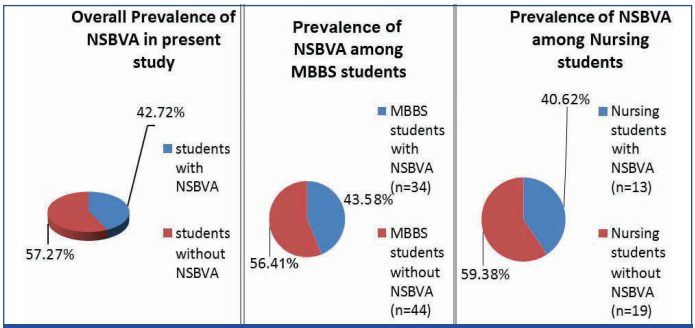
Anomalies	Salient features of binocular anomalies
Convergence insufficiency	Receded Near Point of Convergence (NPC)
	Exophoria more for near than far
	Low Positive Fusional Vergence (PFV) at near
	Low Accommodative Convergence: Accommodation (AC/A) ratio
Convergence excess	Esophoria more for near than far
	High AC/A ratio
	Low Negative Fusional Vergence (NFV) at near
	Fails with minus lenses on binocular accommodative facility test
Divergence insufficiency	Esophoria more at distance than near
	Low AC/A ratio
	Low NFV at distance
Divergence excess	Esophoria more at distance than near
	High AC/A ratio
	Normal PFV at distance and near

[Table/Fig-5]: Salient features of binocular anomalies [6].



[Table/Fig-6]: Sex distribution of NSBVA among students.

Total 47 (42.27%) out of 110 students had NSBVA. Among MBBS students, 43.5% and among nursing students 40.6% had NSBVA [Table/Fig-7].



[Table/Fig-7]: Prevalence of NSBVA among the students in present study.

Prevalence of NSBVA was 41.17% in <20 years age-group, 40.29% in 21-25 years age-group and 66.66% in >25-30 years age-group [Table/Fig-8].

Age group	Total (n)	Students affected by NSBVA (n, %)
≤20 years	34	14 (41.17%)
21-25 years	67	27 (40.29%)
26-30 years	9	6 (66.66%)

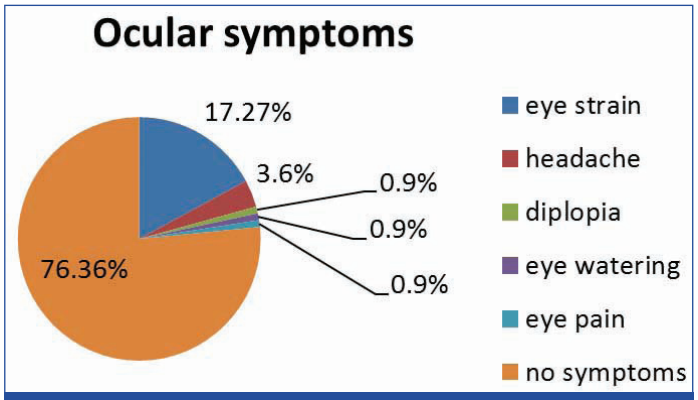
[Table/Fig-8]: Prevalence of NSBVA among different age groups.

Most common NSBVA was accommodation excess found in 18.18% students. Second most common anomaly was Convergence insufficiency with secondary accommodation excess found in 8.18% [Table/Fig-9].

Range of ocular symptoms: Ocular symptoms were present in 26 (23.63%) students. Most common ocular symptom was eye strain seen in 19 (17.2%) students [Table/Fig-10]. Total 12 students (10.90%) had ocular symptoms with NSBVA, 14 students (12.72%) had ocular symptoms without NSBVA whereas 35 students (31.81%) had NSBVA without ocular symptoms and 49 students (44.54%) had neither ocular symptoms nor NSBVA [Table/Fig-11].

NSBVA	MBBS students	Nursing students	Total (%)
Convergence insufficiency	3	1	4 (3.6%)
Convergence insufficiency with secondary accommodation excess	8	1	9 (8.18%)
Accommodation Insufficiency	5	1	6 (5.45%)
Accommodation insufficiency with secondary convergence insufficiency	2	1	3 (2.72%)
Accommodation excess	13	7	20 (18.18%)
Unilateral Accommodation excess	1	1	2 (1.81%)
Accommodation insufficiency	2	1	3 (2.72%)
Total students with NSBVA	34	13	47 (42.72%)

[Table/Fig-9]: Distribution of various NSBVA in MBBS and Nursing students.



[Table/Fig-10]: Distribution of various ocular symptoms in students in the study.

Ocular symptoms	With NSBVA	Without NSBVA
Students with ocular symptoms	12 (10.90%)	14 (12.72%)
Students without ocular symptoms	35 (31.18%)	49 (44.54%)
Total	47	63

[Table/Fig-11]: Distribution of ocular symptoms in students with/without NSBVA.

Among students with NSBVA, the use of electronic devices per day ranged from 2-10 hours/day with a mean of 4.53±1.86 hours/day. Among students without NSBVA, electronic device use ranged between 1-8 hours/day with a mean of 4.36±1.52 hours/day. On comparing the daily duration (number of hours) of electronic devices use among students with and without NSBVA, using Student's t-test, no significant difference was found (p-value=0.06059).

Overall, 63 students (57.27%) out of 110 had refractive error. Most common refractive error was simple myopia. A total of 21 students (44.68%) out of 47 students with NSBVA had refractive error and 42 students (66.66%) out of 63 students without NSBVA had refractive error [Table/Fig-12].

Refractive error	Students with NSBVA	Students without NSBVA	Total
Simple myopia	6	27	33 (29.79%)
Simple myopic astigmatism	2	4	6 (5.45%)
Compound myopic astigmatism	13	9	22 (20%)
Simple hyperopia	0	0	0
Simple hyperopic astigmatic	0	0	0
Compound hyperopic astigmatism	0	1	1 (0.9%)
Mixed astigmatism	0	1	1 (0.9%)
No refractive error	26	21	47 (42.72%)
Total	47	63	110 (100%)

[Table/Fig-12]: Shows distribution of refractive error in students in the study.

[Table/Fig-13] shows students grouped in different categories as per number of hours of exposure of mobile use/day. A total of 17 (36.17%) students out of 47 students with NSBVA and 30 (47.61%)

students out of 63 students without NSBVA belonged to category of 3-5 hours/day of mobile use. On analysing this data from all categories, Chi-square statistic was 1.5586 with p-value of 0.458 showing no significant association of NSBVA with variable duration of hours of mobile use/day.

No of hours of electronic devices like mobile, laptop, tabs etc used/day	No. of students with NSBVA	No. of students without NSBVA	Total	p-value
0-3 hours	16	19	110	χ^2=1.5586, p-value=0.458
>3-5 hours	17	30		
>5 hours	14	14		
Total	47	63		

[Table/Fig-13]: Different categories of duration of electronic device used/day in students with and without NSBVA.
p-value <0.05 was considered as statistically significant, calculated by Chi-square test

[Table/Fig-14] shows duration of regular mobile phone use in students with and without NSBVA. Chi-square test showed a p-value of 0.4399 indicating that there was no significant association of duration of regular mobile use with NSBVA.

Duration of regular mobile use	No. of students with NSBVA	No. of students without NSBVA	Total	p-value
≤5 years	40	50	110	0.4399
>5 years	7	13		
Total	47	63		

[Table/Fig-14]: Shows duration of regular mobile phone use in students with and without NSBVA.
p-value <0.05 was considered as statistically significant; calculated by Chi-square test

DISCUSSION

The MBBS and nursing students are involved in prolonged near tasks like reading, attending online lectures, research work, online exams, working on microscopes etc. Likewise, the use of devices likes mobiles, laptops, computer tablets has significantly increased in recent times. This can put an added stress on their accommodation and vergence mechanisms of eyes and can increase prevalence of NSBVA in them.

In the present study, 42.27% had NSBVA showing a significant prevalence of the anomaly in these students. However, the association between use of electronic devices use like mobiles and laptops with occurrence of NSBVA was not significant.

Atiya A et al., in a similar study done between April 2017 to November 2017, showed NSBVA in 41 (54.66%) out of 75 Ophthalmology trainees [8]. Both these observations indicate a high prevalence of such anomalies in medical students especially those involved in significant near tasks.

Most common NSBVA found in the present study was Accommodation excess in 18.18% students while convergence insufficiency with secondary accommodation excess was second most common anomaly found in 8.18%. Atiya A et al., in their study found convergence insufficiency in 20% and accommodation infacility in 19% of Ophthalmology trainees in their institute [8]. Dahal M and his colleagues, in a study on of NSBVA in Engineering students found accommodation insufficiency in 12.85% and convergence insufficiency in 11.42% of students [9]. This shows that accommodation and convergence anomalies are commonly observed NSBVA among such students with high near task demands.

In the present study, 41.17% students among <20 years age group, 40.29% students between 21-25 years age group, 66.66% between 26-30 years age group were affected with NSBVA. This shows higher prevalence of NSBVA among older age group in the present study students. Magdalene D et al., in a similar study held in North-east India among patients with asthenopic symptoms, found prevalence of NSBVA as 69.35% in 10-20 years age group, 67.35% in 21-30 years age group and 50% in 31-40 years age group [1]. As compared to Magdelene D et al., who showed 50% prevalence of NSBVA among 31-40 years age group, the present study showed 66.66% prevalence of NSBVA among 26-30 years age group [1]. Hence, the present study showed that older age groups in medical field tend to have more prevalence of NSBVA as compared to those among general population.

In the present study, 10.9% students with NSBVA had ocular symptoms while 31.18% students had NSBVA without any ocular symptom. This indicates that ocular symptoms are frequently absent in NSBVA cases and such cases may go unnoticed for a long time before getting diagnosed. Screening of such at risk individuals can help in early diagnosis and treatment of NSBVA before the anomaly gets worsened and symptoms begin to manifest.

The difference with respect to number of hours of electronic devices use/day (like mobile, laptop, computer tablets) in students with and without NSBVA was not statistically significant. This finding is contrary to popular belief that excess mobile or other electronic device use might be associated with increased prevalence of NSBVA among students. Other factors like reading from non-electronic sources (books, journals, notes), other near activities involving frequent change of focus from near to distance and vice versa, family history of NSBVA, diet, systemic illnesses should also be considered before making such a comparison.

The present study showed 57.27% (63 out of 110) prevalence of refractive error in overall sample. 44.68% of students with NSBVA and 66.66% students without NSBVA had refractive errors. This showed a high prevalence of refractive errors in both groups. [Table/Fig-15] [8-12] shows various studies on NSBVA in different student population in recent times and most common anomalies found in respective studies. It is clear from this table that NSBVA is highly prevalent in student populations especially those with increased demands of near tasks.

Study	Place of study	Study participants	Prevalence of NSBVA	Most common NSBVA found
Present study (2022)	Teaching Hospital in Western Maharashtra	MBBS and nursing students	42.27%	Accommodation excess
Dahal M et al., (2021) [9]	Kathmandu	Engineering students	71.41%	Accommodation insufficiency
Atiya A et al., (2020) [8]	Tertiary eye care centre, South India	Ophthalmology trainees	55%	Convergence insufficiency
Ali J et al., (2020) [10]	School, Gorakhpur	School children	36%	Convergence insufficiency
Mondal A and Soumiya, (2020) [11]	Manglore	College students	76%	Convergence insufficiency
Darko-Tayki C et al., (2016) [12]	Ghana	Optometry students	34%	Accommodative fatigue

[Table/Fig-15]: Shows common NSBVA found in various similar studies [8-12].

Medical and nursing students have high visual demands. These demands increase when they move on from under graduate to post graduate career when they are involved into more clinical work and responsibility and also they have to read more and be involved in research activities. Many students are also involved in assisting in microscopic and laparoscopic surgeries and working on microscopes in labs which is an added ocular stress. The present study has found significant prevalence of NSBVA in under graduate medical and nursing students which can aggravate and become worse in their future career. Undiagnosed NSBVA can become decompensated causing worsened symptoms, decreasing work efficiency and poor job satisfaction. So, early diagnosis of such anomalies is very important in this group of population. It is suggested that evaluation of NSBVA should be a part of Ophthalmic

evaluation in both undergraduate and postgraduate medical and nursing students for early diagnosis of NSBVA.

Limitation(s)

Small sample size was the limitation of the present study. Future studies should aim at larger sample size of medical students and focus on treatment outcomes of orthoptic exercises for NSBVA in such students.

CONCLUSION(S)

Non strabismic binocular vision anomalies is highly prevalent among MBBS and nursing students with older age group being more affected. Many students with NSBVA do not show ocular symptoms, so the diagnosis of such anomaly may be delayed. Screening of students from medical and nursing background can help in timely diagnosis and treatment of NSBVA. There was no association of NSBVA with use of electronic device use in these students. Research aiming to study treatment outcomes of NSBVA in these students using vision therapy and orthoptic exercises is recommended.

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