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Research Article

Prevalence of Ocular and Visual Anomalies in Students with Autism Spectrum Disorder (ASD)

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Abstract

Purpose: To determine the prevalence of ocular and visual anomalies in students with Autism Spectrum Disorder (ASD).

Methods: This case-series in 2015-16 included students with ASD of two special schools of Bangalore, India. Comprehensive ocular and vision examination also included accommodation by dynamic retinoscopy and convergence. The amplitude of accommodation was calculated by Hofstetter minimum formula. The accommodative facility was measured by referring to the cycles of accommodative flippers, used ± 2.50D and 14 cycles/min considered as normal. Saccades were tested using Marsden ball movements. Additional eye testing at our institute was with Vision therapy system, ocular motility testing and alternate prism cover test.

Result: The 120 students with ASD had a mean age of 12.9 ± 1.7 years. They included autism 58 (48.3%), ASD 27 (22.5%) and other 34 (28.3%). Spectacles correction was needed in 62 (51.7%) students. Refractive error included myopia (57; 92%), hyperopia (5; 8%), myopic astigmatism (3; 4.8%), and mixed astigmatism (2; 3.2%). The compliance of spectacle wear was 12/62 (19.4%) only. Strabismus was seen in 68 (56.7%) students. Accommodative convergence was 4 to 28 mm. Non-accommodative convergence was 4 to 37 mm. Pursuit

movements were poor in 35 (29.2%), average in 39 (32.5%), good in 46 (38.3%) students. The saccadic eye movements were good in 100 (83.3%), average in 15 (12.5%) and poor in 5 (4.2%) students.

Conclusion: More than half of students with ASD had at least one ocular morbidity. The commonest was refractive errors followed by strabismus. Periodic and comprehensive ocular assessment of autistic students is recommended.

Keywords: Autism; Refractive error; Visual disability; ocular motility

1. Introduction

Autism spectrum disorders (ASD) are a group of neurodevelopmental disorders, characterized by various kind of behaviours impacting social interaction marked by impaired verbal and non-verbal communication, specific repetitive or stereotyped behaviour, toe walking, hyperactivity and hypo activity at times [1, 2]. Prevalence of autism is about 1-2 per 1000 people worldwide and occurs about 4 times more often in boys. As per the Center for Disease Control and Prevention (CDC) report 1.5% of students in US (1 in 68) are diagnosed with ASD as of 2014, which was a 30% increase (1 in 88) from the year 2012 [3, 4]. ASD conditions are reported to be associated with amblyopia, ocular motility restriction, binocular anomalies with or without strabismus, poor visual performance and difficulties with visual perception [5, 6]. The literature regarding visual status in students with ASD residing in developing countries is not large, which could either be due to the difficulty in assessing these students or lack of awareness regarding the visual deficits that could be present in these students [7, 8]. To the best of our knowledge, visual and ocular profile of students with ASD have not been studied in India. This manuscript presents the visual, refractive, ocular motility, binocular vision and accommodative status of students associated to autism and spectrum disorder.

2. Methods

This was a cross sectional type of study. The institution research board of Sankara College of Optometry, Bangalore approved of the study. We obtained verbal consents of parents for assessing persons with ASD. The participants belonged to two special learning schools at Bangalore, India. One optometrist and one teacher of students with special needs were field investigators. One ophthalmologist and one epidemiologist assisted in planning, analysing the study data and interpretation of outcomes. Autism Spectrum Disorders in this study included Autistic Disorder, Asperger Syndrome and Pervasive Developmental Disorder (PDD-NOS) under Autism; Spectrum Disorder includes Attention Deficit Disorder (ADD), Attention Deficit Hyperactivity Disorder (ADHD); other disorders include Cerebral Palsy, Mental Retardation and Epilepsy. As per medical records copy that was brought by parents and school teachers, the diagnosis and on its basis classification of ASD was done by institutional team of paediatric ophthalmologist, paediatric optometrist, vision therapist and psychologist. The diagnosis had been made by the team at National Institute of Mental Health and Neuroscience Bengaluru Institute.

The ocular assessment was conducted in the school for special students. LEA symbols chart (100% contrast) in a light box was held at 3-meter distance from the participant. The chart was LEA Distance Chart ETDRS (3 m, Article No.80010). Size: 62 × 65 cm with optotypes: LEA symbols on translucent plastic, washable for Visual acuity up to 3.0 (at 6 m distance), with 1 answer chart and 4 answer cards. The manufacturer was VISUS Sehteste (Herrenberg, Germany) [9].

We maintained even illumination of around 70 lux in the lightbox. Vision was tested binocularly. For each correct symbol identified, 0.02 LogMAR value was added in the visual acuity notation of the previous line from the top. If visual acuity could not be tested due to poor cooperation, Lea Paddle was held at one-meter distance from the participant and the visual acuity was noted in cycle per second. This was done when the child would not tolerate the occlusion also verbal response was not reliable and by matching we have received varied responses. Refractive corrections ware found by retinoscopy method.

We evaluated the refractive status of each eye separately and vision in both eyes together. Heine Beta 200 yellow light streak retinoscope (Heine, Germany) was used for objective evaluation of refractive error. Dynamic retinoscopy was done by MEM method by using Clore MEM card over streak retinoscope. Based on the dynamic refraction (spherical equivalent of less than 2D astigmatism), each eye was categorised as emmetropic (<-0.25 to =0.5D), myopic (mild; <-0.25 to -2.0D, moderate; <-2.0D to -6.0D and severe; <-6.0D), hyperopic (>0.5D and astigmatic (>2D) [10].

The accommodation was tested using Clore Monocular Estimation Method (MEM) figure card stuck to the direct retinoscope [11]. The MEM technique near retinoscopy or dynamic retinoscopy was the technique used. The lights in room were kept dim so that pupils would be adequately dilated and did not affect eye examination. If refractive status changed to hyperopic after fixing at near point, the accommodation was considered as normal. If there was no change in refractive status after fixing near point, accommodation was considered as lagging [12]. If there was a change of refractive status towards the myopic side, while fixing at a near target, the focus was forming before target, and the accommodation was considered as leading.

Near point of accommodation (NPA) was measured by keeping a N8 target in front of the eyes and by pulling away the target first fixation noticed. Monocular Estimation Method (MEM) was performed to measure near point of accommodation and to find out dioptric values. Near point of convergence (NPC) was measured by Pencil Push Up method. We had attached a N8 size target to an Ice cream stick and performed the process. Red Glass test was performed to find out the non-accommodative convergence (Colour disassociation method). We gave accommodative target to the patient to see the convergence difference between the accommodative convergence and non-accommodative convergence by using a red glass by colour disassociation method.

Saccades and pursuits were measured with a technique using the Marsden ball [13, 14]. They were graded as 'Good' if fixation tracking and further fixation was good. The grading was categorized as 'Average' when the fixation and tracking was happening, but further fixation was creating a problem. The grading was categorized as 'Poor' if either fixation and/or tracking was affected. The ball was swung thrice in front of the participant with N18 target attached with the ball. In this study, we have tried with different colour pictures printed on the ball, maintained the size of the target same as N18. Also, different animal, birds pictures with higher and lower frequency color were considered. The low frequency colors used were green, violet, red parrots and same colored deer, in this study. Angle of deviation (Strabismus) was measured for distance and near, distance at 3 meters and near at 40 cm by a prism bar using the alternate prism bar cover test method. It was classified as esophoria/tropia, exophoria/tropia and orthophoria.

3. Results

Our series had 120 students with ASD. Their mean age was 14.6 ± 7.7 years. Boys were 94 (78%) and girls were 26 (22%). 46 (38.3%) students were from ASHA Institutions and 74 (61.7%) were from NIMHANS, Bangalore Institute. The diagnosis was autism in 58 (48.3%), ASD in 27 (22.5%) and other in 34 (28.3%) of participants. Eighty-two (68.3%) students were compliant to systemic medication while 37 (30.8%) students were occasionally compliant for medication for ASD. Only one child was not advised medicines. The BCVA was 6/6 in all students on ETDRS visual acuity chart. The uncorrected visual acuity was 6/6 in both eyes in 57 (47.5%), 6/9 in worse eye in 12 (10%), 6/12 in 38 (31.7%), 6/18 in 13 (12.8%) students. Amongst 120 participants, 62 (51.7%) required spectacles correction and achieved visual acuity 6/6. Simple myopia (12; 19%) mixed astigmatism in (37; 58.7%) and myopic astigmatism was in 8 (12.6%) students. Hyperopia was found in 5 (8%) students with refractive errors. On the day of study visit, 12 students (19.4%) students were wearing spectacles. These had been dispensed on an earlier visit a year ago. The status of accommodation distance and vengeance distance is given in Table 1. Accommodation did not vary much in each eye (Table1). Accommodative convergence (NPC) was varying from 4-28 mm while non-accommodative convergence (NPC) was 4-37 mm (with red glass) (Table 1).

	Median	**25% quartile**	**Minimum**	**Maximum**
Near point of convergence (NPC) (mm)	10	6	4	28
NPC tested with red glass (mm)	14	10	4	37
Near point of accommodation (right eye) (cm)	9	8	5	30
Near point of accommodation (left eye) (cm)	9	8	5	30
Near point of accommodation (both eyes) (cm)	10	8	5	30

mm = millimeter; cm = centimeter

Table 1: Accommodation and convergence distance for near vision in persons with Autism spectrum disorders.

Pursuit movement were poor in 35 (29.2%), average in 39 (32.5%) and good in 46 (38.3%) participants. The saccadic eye movements were good in 100 (83.3%), average in 15 (12.5%) and poor in 5 (4.2%) of ASD patients. Here we have found coloured target, [15] specifically high frequency colours, excited the participant and they started not to follow the ball. Participant preferred low frequency colours and target with birds, rather fonts or animals [15]. 68 (56.7%) participants had strabismus. 29 had tropia (24 exotropia and 5 esotropia) and 39 (30 exophoria and 8 esophoria) students had phoria. Table 2 reports the type of refractive error by gender, age group and type of autism. The variation of refractive error by type of autism (P=0.01) and age group (P <0.01) were significant, but not by gender (P=0.3).

Characteristics		**Hyperopia (N = 5)**		**Myopia (N = 12)**		**Emmetropia (N = 58)**		**Other (N = 45)**		**Validation**
		Number	%	Number	%	Number	%	Number	%	
Gender	Male	4	80	10	83.3	47	81.0	33	73.3	c^2 =1
	Female	1	20	2	16.7	11	19.0	12	26.7	Df =4
										P = 0.3
Type	Autism	2	40	4	33.3	23	39.7	29	64.4	c^2 =16
of Autism	Spectrum	1	20	1	8.3	20	34.5	5	11.1	Df =6
	Other	2	40	7	58.3	15	25.9	10	22.2	P = 0.01
Age group	5 to 9	2	40	3	25.0	20	34.5	9	20.0	c^2 =33
In Years	10 to 14	2	40	3	25.0	22	37.9	15	33.3	Df =9
	15 to 20	1	20	2	16.7	2	3.4	16	35.6	P <0.001
	> 20	0	0	4	33.3	1	1.7	18	40.0	

Table 2: Refractive error and determinants among children with autism.

4. Discussion

More than half students with ASD had at least one ocular morbidity, the commonest being refractive errors followed by strabismus. This is perhaps the first study from India, which demonstrated visual, refractive status and other ocular evaluation results in special kids with ASD. The study showed significant result on accommodation, convergence, impact of colors. It also showed poor compliance of spectacles wear. With such high rates of ocular problems among ASD, initial comprehensive assessment of all students diagnosed with ASD is recommended. Assessment should be followed by action oriented remedial or care system to monitor the improvement and progress in quality of life of the child. Ocular problems in ASD noted in the present study were much more than Omani students of similar age groups; both normal as well as with special needs [12]. The higher than 40% eye problems among students with intellectual disabilities was also noted by Li et al. [13]. In the study from Oman, a

comprehensive Lea -Vision assessment kit was used [16, 12]. Differential tests and tools could be the reason for higher rates of ocular problems in students with ASD in the present study.

The increased prevalence of refractive errors and strabismus is in line with results from Oman and Pune India that showed that special students have higher ocular morbidity [12, 17]. The refractive error and strabismus prevalence was much more than that in normal students from South India as found in a population based study [18]. Saccades movements were more affected than Pursuits. This could be the reason why there is reduced visual exploration when viewing photographic scenes in individuals with ASD as described by Heaton et al. [19]. Shirama et al. have reported that the ASD group showed difficulty in maintaining fixation especially when there was no fixation target. In this study, we have found poor pursuits and visual tracking because of that. Shirama et al. opined that ASD adults have deficits in converting alternative sensory information, such as retinal signals in the peripheral visual field or extra-retinal signals, to motor commands when the foveal information was unavailable [5]. This study was a preliminary exploration of ocular co-morbidity in students with ASD. A more detailed study with longer follow-up focusing on compliance to spectacle wear and difference in vision function is needed. The major limitations are that we did not measure visual acuity of each eye separately and cycloplegic refraction was not done. As the examinations were performed in a school setting, the vision therapy software was not used for this purpose.

More than half of students with ASD had at least one ocular morbidity. The commonest was refractive errors followed by strabismus. Periodic and comprehensive ocular assessment of autistic students is recommended. Referrals should be followed up dedicatedly.

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