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THE ASSOCIATION BETWEEN ANISOMETROPIA AND BINOCULAR VISUAL FUNCTION

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Abstract

The Purpose of the study was to evaluate the effect of anisometropia on binocular status in healthy adults. One to five dioptres of unilateral hyperopia and myopia were induced in 30 adults by putting experimental lens in the trial frame in front of the eye concerned. The effect of induced anisometropia on binocularity in the eye was assessed with the worth-four Dot test for distance and near, Bagolini's test to assess fusion and the TNO test for stereopsis. On WFDT for distance, with induced hyperopia and myopia in either eye, all subjects lacked BSV ($p<0.05$). And for near all subjects demonstrated BSV. On Bagolini test with increasing hyperopia and myopia, fusion response was significantly deterioted and On TNO test, all patients had a significant worsening in the stereoacuity (p<o.o5). So the present study concluded that small amounts of anisometropia (<1D) can have a significant adverse effects on binocular interaction.

Keywords: *Anisometropia, Binocular single vision, Hyperopia, Myopia*.

Introduction

Any obstacle during the development of the complex functions of binocular co-operation may alter the binocular outcome. Anisometropia is one such extremely important obstacle in this regard. In smaller degrees of anisometropia, binocular vision is the rule but with higher degrees of anisometropia, fusion is impossible and this can lead to the development of foveal suppression, amblyopia, abnormal retinal correspondence and strabismus. In a clinical setting anisometropia invariably accompanies anisokonia and they may together lead to an increase in amblyopia and strabismus. The amblyopia in most cases is preventable since useful vision may be retained if the refractive error is recognized and corrected early in life.

While the exact prevalence of anisometropia in the general population is not known, a prevalence of 4-4.7% has been described in the literature. (Vries De J. 1985)

The present study had been undertaken to evaluate the possible decrimental effects of induced anisometropia in a healthy population of adults. Although it would most likely be decrimental in the younger child. It was difficult to clinically get the responses in this age group, and therefore inducing anisometropia in adults allowed us to evaluate its effects on various aspects of binocular vision, presuming that the sensory blurring produced experimentally mimics that experienced by an anisometropic child with an equivalent amount of monocular blur. Also we aimed to evaluate whether the degradation of binocular function is different when the induced anisometropia is on the dominant or non-dominant eye.

Materials and Methods:

The present study was conducted on 30 normal adults, at the strabismus clinic, institute of ophthalmology, J. N. Medical college, A.M.U., Aligarh. After ethical clearance was obtained from the Board of studies, AMUIO, subsequent to an explanation regarding the purpose and the methodology involved, an informed consent was taken from the individuals, prior to their inclusion in the study. Inclusion criteria were: adults aged 18-35 years, UCVA of 6/6, no previous therapy for amblyopia, no other ocular pathology, absence of manifest strabismus on cover test. Subject with less than 4Δ of heterophoria were excluded. Directional dominance of the eye was established by the pointing test. One to five dioptres (D) of unilateral hyperopia and myopia were induced in 30 normal adults aged between 18-35 years by putting experimental lens in the trial frame in front of the eye concerned. The induction was done in 1D steps in front of first, the right eye and then the left eye. The effect of induced anisometropia on binocularity in the dominant and the non dominant eye was assessed with the worth-four Dot test for distance and near and Bagolini's test to assess fusion and the TNO test for stereopsis.

Statistical analysis was done by using chi-square, Mc Nemar and Wilcoxon tests.

Results

Out of the total 30 cases, the females comprised of 60% of the cases while the males were 40% of the total. The number of adults with the right eye as the dominant eye was 27 (90%) as compared to those having the left eye dominant 3(10%).

Worth-four test for distance (table 1): With +1D of induced hyperopia in the right eye, 28 demonstrated BSV. The number of subjects showing BSV decreased to 12 with +2D of induced hyperopia. With +3D to +5D of induced hyperopia, all lacked fusion. There was a statistically significant change between +1D with +2D of induced hyperopia and +2D with +3D of induced hyperopia, with p value <0.05.

With induction of +1D of hyperopia in the left eye, 24 subjects showed BSV. Whereas with +2D of induced hyperopia, the number of subjects showing BSV was reduced to 8. All lacked fusion with +3D to +5D of induced hyperopia. The p value was significant for the changes between isometropia and +1D, +1D and +2D, and +2D and +3D. With -1D of induced myopia in the right eye, all 30 subjects demonstrated BSV, whereas with -2D of induced myopia, the number of subjects showing BSV further fell to 11. With -3D to -5D of induced myopia all lacked BSV. When -1D of myopia was induced in the left eye, 24 subjects showed BSV. The number of subjects showing BSV decreased to 7 with -2D of induced myopia. All subjects lacked fusion with -3D to -5D of induced myopia over the left eye.

Table 1: Number(%) of subjects with BSV or suppression with increasing anisometropia (N=30) on worth four dot test for distance (6mts)

Anisometropia induced (D)	BSV	Suppression	P value (Mc Nemar)
Hyperopia (Right eye)			
+1	28(93.3)	2(6.7)	0.500
+2	12(40)	18(60)	<0.001
+3	0(0)	30(100)	<0.001
Hyperopia (left eye)			
+1	24(80)	6 (20)	0.031
+2	8 (26.8)	22 (73.3)	0.001
+3	0 (0)	30 (100)	0.008
Myopia (right eye)			
-1	30(100)	0(0)	NS
-2	11(36.7)	19(63.3)	<0.001
-3	0(0)	30 (100)	0.001
Myopia(left eye)			
-1	24(80)	6 (20)	0.031
-2	7(23.3)	23 (76.7)	<0.001
-3	0(0)	30 (100)	0.016

The worth four test for near (33cm): all the subjects demonstrated BSV with all induced anisometropic powers in either eye.

The Bagolini's lenes test at 6 mts (table 2):

On induction of +1D of hyperopia in the right eye, 28 subjects had BSV where as the number of subjects showing BSV was decreased to 10 when +2D of hyperopia was induced in the same eye. With +3D to +5D of induced hyperopia all lacked fusion. With +1D over the left eye, 23 demontrated BSV and with +2D, 6 subjects showed BSV. with +3D of induced hyperopia and further increasing plus powers till +5D over the left eye, all lacked fusion.

With the induction of -1D of myopia in front of the eye, all 30 subjects showed BSV. with -2D of induced to 10 and with -3D of induced myopia, only 1 subject had BSV, with -4D to -5D of induced myopia. all lacked fusion.

With -1D in front of the left eye, 24 subjects had BSV. With the induction of -2D over the left eye, 5 subjects had BSV. With -3D to -5D over the left eye all lacked fusion.

Table 2: number of subjects with BSV or suppression with increasing anisometropia (N=30)

Anisometropia Induced (D)	BSV	SUPPRESSION	P Value (Mc Nemar)
Hyperopia (Right eye)			
+1	28 (93.3)	2 (6.7)	0.005
+2	10 (33.3)	20 (66.7)	<0.001
+3	0 (0)	30 (100)	0.002
+4	0 (0)	30 (100)	NS
+5	0 (0)	30 (100)	NS
Hyperopia (left eye)			
+1	23 (76.7)	7 (23.3)	0.016
+2	6 (20)	24 (80)	<0.001
+3	0 (0)	30 (100)	0.031
+4	0 (0)	30 (100)	NS
+5	0 (0)	30 (100)	NS
Myopia (Right eye)			
-1	30 (100)	0 (0)	NS
-2	10 (33.3)	20 (66.7)	<0.001
-3	1 (3.3)	29 (96.7)	0.004
-4	0(0)	30 (100)	1.000
-5	0 (0)	30 (100)	NS
Myopia (Left eye)			
-1	24(80)	6 (20)	0.031
-2	5 (16.7)	25 (83.3)	<0.001
-3	0 (0)	30 (100)	0.063
-4	(0)	30 (100)	NS
-5	0 (0)	30 (100)	NS

The p value was not significant when the response in the right eye was compared with that in the left eye for increasing pius powers, upto +5D of induced hyperopia.

When -1D of induced myopia in the right eye was compared with same amount of induced myopia in the left eye, the p value of the difference was statistically significant. Whereas the p value for the difference between the right and left eye with increasing minus powers was not statistically significant.

The TNO random dot test (table 3): with each D of hyperopic induction in either eye, on the TNO Test, all patients had a significant worsening in the stereoacuity ($p<0.05$) in proportion to the degree of hyperopia induced. With +5D of induced hyperopia , in either eye, all subjects had a stereoacuity worse than 480 arc seconds. Inducing minus powers, in either eye, revealed that the stereoacuiity, in all subjects worsened significantly ($p<0.05$) in proportion to the degree of myopia induced. In the right eye by -4D, all subjects had a stereoacuity of worse than 480 arc seconds, whereas, with -3D over the left eye, 29 subjects attained a stereoacuity of worse than 480 arc seconds. When hyperopia or myopia of 1D was compared in right and the left eyes, a significant p value was obtained. When higher grades of hyperopia or myopia were compared in the right and left eye, for each diopteric induction, the p value was not statistically significant.

Table 3: Number (%) of subjects, demonstrating different levels of stereoacuity with increasing anisometropia (N=30) on TNO test.

Anisometropia Induced (D)	Stereoacuity in Arc Secs.				
	120	**240**	**480**	**>480**	**P Value (wilcoxon)**
Hyperopia (Right eye)					
+1	12 (40)	8 (26.7)	10 (33.3)	0 (0)	<0.001
+2	5 (16.7)	3 (10)	11 (36.7)	11 (36.7)	<0.001
+3	0 (0)	1 (3.3)	7 (23.3)	22 (73.3)	<0.001
+4	0 (0)	0 (0)	2 (6.7)	28 (93.3)	0.008
+5	0 (0)	0 (0)	0 (0)	30 (100)	0.157
Hyperopia (Left eye)					
+1	9 (30)	5 (16.7)	10 (33.3)	6 (20)	<0.001
+2	4 (13.3)	1 (3.3)	9 (30)	16 (53.3)	<0.001
+3	0 (0)	1 (3.3)	4 (13.3)	25 (83.3)	0.002
+4	0 (0)	0 (0)	1 (3.3)	29 (96.7)	0.025
+5	0 (0)	0 (0)	0 (0)	30 (100)	0.317
Myopia (Right eye)					
-1	14 (46.7)	9 (30)	7 (23.3)	0 (0)	<0.001
-2	0 (0)	5 (16.7)	14 (46.7)	11 (36.7)	<0.001
-3	0 (0)	0 (0)	5 (16.7)	25 (83.3)	<0.001
-4	0 (0)	0 (0)	0 (0)	30 (100)	0.025
-5	0 (0)	0 (0)	0 (0)	30 (100)	1.000
Myopia (Left eye)					
-1	10 (33.3)	3 (10)	12 (40)	5 (16.7)	<0.001
-2	1 (3.3)	1 (3.3)	8 (26.7)	20 (66.7)	<0.001
-3	0 (0)	1 (3.3)	0 (0)	29 (96.7)	0.004
-4	0 (0)	1 (3.3)	0 (0)	29 (96.7)	1.000
-5	0 (0)	1 (3.3)	0 (0)	29 (96.7)	1.000

Table 4: Comparison of the TNO test for the right and the left eye for the same diopteric power.

Anisometropia Induced (D)		P value (wilcoxon)
Right eye	**Left eye**	
+1	+1	0.026
+2	+2	0.084
+3	+3	0.429
+4	+4	0.564
+5	+5	1.000
-1	-1	0.010
-2	-2	0.081
-3	-3	0.317
-4	-4	0.317
-5	-5	0.317

Discussion

Anisometropia is a common problem that can cause amblyopia as well as a disruption of binocularity (Goodwin RT. 1985). However, the levels of anisometropia that warrant correction in young children and the age at which such correction should be initiated to prevent abnormal visual maturation remain unclear. To gain insight into the issue, we attempted to determine the levels at which anisometropia would interfere with high grade binocular function in adults which we expect to be similar in children.

In our study, the number of adults with right eye as the dominant eye was 27(90%) as compared to those having the left eye dominant which was 3(10%). On WFDT for distance, induced hyperopia over either eye, the number of subjects showing BSV decreased significantly ($p<0.05$) in proportion to the increasing hyperopia. With +3D to +5D of induced hyperopia, all lacked fusion.

It is likely that the size of the suppression zone increased with increasing anisometropia as also shown by previous studies (Dedya S. , Brookes SE. 2001).

With -1D of induced myopia in the right eye, all 30 subjects demonstrated BSV, whereas with -2D of induced myopia, the number of subjects showing BSV further fell to 11. With -3D to -5D of induced myopia all lacked BSV. In the left eye, with -1D, 24 subjects showed BSV as compared to 7 with -2D. Again with -3D to -5D of induced myopia all lacked BSV. Brooks et al [4] found in their study that with 2D of spherical anisometropia, none was able to fuse on WFDT. The WFDT for near, all the 30 subjects demonstrated BSV with all induced anisometropic power in either eye. We agree with Tomac and Birdal (tomac S. 2001) on their view that anisometropica induces foveal rivalty. It is this fact which allows the WFDT for near to give a fusion response through peripheral fusion mechanisms while the WFDT for distance shows suppression as it tests for foveal fusion.

The Bagolini lens test at 6 mts showed that with increasing hyperopic or myopic induction in either eye , there was a significant deterioration in the fusion response ($p<0.05$) in proportion to the increasing anisometropia. All subjects showed a lack of fusion with +3D of induced hyperopia in either eye. With induced myopia of -4D in right eye and -3D in the left eye, all subjects lacked fusion. The p value was not significant when the response in the right eye was compared with that in the left eye for each hyperopic or myopic induction except for -1D of induced myopia which showed that -1D of induced myopia was more detrimental to the non dominant left eye as compared to the dominant right eye.

With each D of hyperopic induction in either eye, on the TNO Test, all patients had a significant worsening in the stereoacuity ($p<0.05$) in proportion to the degree of hyperopia induced. With +5D of induced hyperopia , in either eye, all subjects had a stereoacuity worse than 480 arc seconds. Inducing minus powers, in either eye, revealed that the stereoacuiity, in all subjects worsened significantly ($p<0.05$) in proportion to the degree of myopia induced. In the right eye by -4D, all subjects had a stereoacuity of worse than 480 arc seconds, whereas, with -3D over the left eye, 29 subjects attained a stereoacuity of worse than 480 arc seconds. When hyperopia or myopia of 1D was compared in right and the left eyes, a significant p value was obtained. When higher grades of hyperopia or myopia were compared in the right and left eye, for each diopteric induction, the p value was not statistically significant.

Our findings correlate well with those of Oguz and Oguz (Ogus H. 2000) who observed in their study that 3D of anisometropia caused marked reduction of stereoacuity in all their patients, also consistent with those of Dadeya et al who reported similar findings.

Our study also shows that as little as 1D of anisometropia, regardless of the type has the potential to degrade stereopsis significantly to subnormal levels in visually mature adults. This is in agreement with the findings of Peters (Peters HB. 1969) who reported that in 80% of his subjects significant deterioration in stereopsis occurred with 1D of monocular blur.

So our study may conclude that small amount of spherical anisometropia (<1D) can have a potentially significant adverse effects on high grade binocular interaction and therefore this fact must be considered when correcting refractive errors in children. The mechanisms underlying the loss of binocularity seem to involve foveal suppression, the extent of which is directly related to the degree of anisometropia.

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