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RESEARCH ARTICLE

Effects of different types of refractive errors on bilateral amblyopia

Farklı refraktif bozuklukların bilateral ambliyopiye etkileri

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ABSTRACT

Objectives: Identifying effects of different types of refractive errors on final visual acuity and stereopsis levels in patients with bilateral amblyopia.

Materials and methods: Patients with bilateral amblyopia lower than ≥1.5 D anisometropia were included. The patients were classified according to the level of spherical equivalent (0-4 D and >4 D of hypermetropia), the level of astigmatism (below and above 2D in positive cylinder) and type of composed refractive error [<4 D of hypermetropia and < 2 D of astigmatism (group I), > 4 D of hypermetropia and < 2 D of astigmatism (group II), and < 4 D hypermetropia and > 2 D of astigmatism (group III)]. Initial and final binocular best corrected visual acuities (BCVA) were compared between groups.

Results: The initial binocular BCVA levels were significantly lower in patients with > 4 D of hypermetropia (p=0.028), without correction after treatment (p=0.235). The initial binocular BCVA was not different between astigmatism groups, but final BCVA levels were significantly lower in 4-6D of astigmatism compared with 2-4 D of astigmatism (p=0.001). During comparison of composed refractive errors, only the initial binocular BCVA was significantly lower in group I compared to group II (p=0.015). The final binocular BCVA levels were not different between groups I and III (p>0.05).

Conclusions: Although the initial BCVA is lower in patients with higher levels of hypermetropia, the response of patients to treatment with glasses is good. The response of patients with high levels of astigmatism seems to be limited. *J Clin Exp Invest 2012; 3(4): 467-471*

Key words: Amblyopia, isoametropic amblyopia, hypermetropia, refractive amblyopia, visual acuity

ÖZET

Amaç: Bilateral ambliyopi olan hastalarda farklı tiplerdeki refraktif kusurun görme keskinliği ve stereopsis üzerine olan etkilerinin belirlenmesi amaçlanmıştır.

Metod: Bilateral ambliyopi olup ≥1,5 D anizometropisi olmayan hastalar çalışmaya alınmıştır. Hastalar sferik eşdeğer seviyeleri (0-4 D ve >4 D hipermetropi), astigmatizm düzeyleri (pozitif silindirde 2D'nin altı ve üstü) ve kırma kusurunun cinsine [<4 D hipermetropi ve < 2 D astigmatizm (grup I), > 4 D hipermetropi ve < 2 D astigmatizm (grup II), ve < 4 D hipermetropi ve > 2 D astigmatizm (grup III)] göre gruplandırılmıştır. Gruplar arasında ilk ve sonuç en iyi düzeltilmiş görme keskinliği (EDGK) karşılaştırılmıştır.

Bulgular: > 4 D hipermetropisi olan hastalarda başlangıç EDGK belirgin olarak düşük bulunmuştur (p=0,028) ancak gözlük tedavisi sonrası ölçülen sonuç EDGK değerleri farkı istatistiksel olarak anlamlı bulunmadı (p=0.235). Astigmatizm değerlerine göre sınıflanan gruplarda (<2 D, 2-4 D, 4-6D astigmatizm) başlangıç EDGK değerleri farklı değilken sonuç EDKG ölçümleri 4-6D astigmatizm olanlarda ve 2-4 D astigmatizm olanlara göre anlamlı olarak düşük bulundu (p=0,001). Refraktif kusur derecesine göre karşılaştırıldığında yalnızca ilk EDGK değerleri 1. grupta 2. gruba göre anlamlı derecede düşük bulundu (p=0,015).

Sonuç: Yüksek derecede hipermetropisi olan hastalarda ilk ölçülen EDGK değerleri düşük olsa da hastaların gözlük tedavisine olan cevapları iyidir. Ancak yüksek derecede astigmatizm olanlarda bu cevap sınırlıdır.

Anahtar kelimeler: Göz tembelliği, görme keskinliği, hipermetropi, izoametropik Ambliyopi, refraktif ambliyopi

INTRODUCTION

Bilateral amblyopia is rare, but is a real danger for vision in children with especially high refractive errors.[1-2] Its estimated prevalence in children entering school is reported as 0.5 % (four of 830 children) to 1 in every 1000 children.[1-3] It can be easily diagnosed in patients with high refractive errors. In clinical practice amblyopic patients with different types of refractive errors can be observed. There are few

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limited reports comparing response of patients with bilateral amlyopia with different types of refractive errors.[3] We aimed to evaluate the amount of binocular visual acuity improvement of these patients with different refractive errors after treatment of amblyopia by optical correction.

MATERIALS AND METHODS

The study enrolled patients with bilateral refractive amblyopia excluding those with >1.5 D anisoametropia (spherical equivalents), myopic or hypermetropic spherical equivalents more than 8 D, ocular albinism, ocular disease or history of ocular surgery, a neurological disease or syndrome. The research followed the tenets of the Declaration of Helsinki, with local ethical committee approval and the full, informed consent of parents and assent from the children. Each subject had complete routine ophthalmological examination. Bilateral amblyopia was defined as 6/10 to 6/60 best corrected visual acuity (BCVA) OU on the Snellen chart or the tumbling "E" chart. Best corrected visual acuity was measured after the refraction by using trial frames at both first and the final examinations. The test distance was 6 meters and the tester knowing the child's refractive error. The best corrected visual acuity value was accepted as the line where at least 4 letters from 5 can be identified by the patient. The refractive errors of all patients were measured after topical cyclopentolate 1% (dropped three times with 5 minutes interval) application 45 minutes after the last drop with the retinoscopy. The sphere was corrected partially 1-1.5 D below the cycloplegic hyperopic correction. and the cylinder was given in full. Each 26 patient was followed with only optical correction. The best level of visual acuity reached was confirmed with pinhole disc in each patient.

Stereopsis was tested with refractive correction by the TNO test before dilating the pupil in the first visit and the final visit with prescribed glasses.

The patients were classified according to the level of spherical equivalent (0-4 D and >4 D of hypermetropia), the level of astigmatism (below and above 2D in positive cylinder) and type of composed refractive error [<4 D of hypermetropia and < 2 D of astigmatism (group I), > 4 D of hypermetropia and < 2 D of astigmatism (group II), and < 4 D hypermetropia and > 2 D of astigmatism (group III)]. Initial and final binocular best corrected visual acuities (BCVA) of the patients between groups were compared.

Visual acuity data for patients were converted to a common logarithm of the minimum angle of resolution (logMAR) scale for statistical analysis. The mean of best corrected binocular BCVA levels of patients at admission and at the last control visits were compared by the Mann Whitney-U test. The patient groups classified according to refractive errors were compared by the Kruskal-Wallis test and in case of significance pairwise comparisons were done by the Mann Whitney U test. The stereopsis ratios of groups at the final visit were compared by the chi-square test. The p values below 0.05 were considered significant.

RESULTS

Thirty nine patients with bilateral refractive amblyopia with a mean follow up of 2.49±1.46 years (min: 6 months- max: 6 years) were enrolled in this study. The mean age of patients was 7.29±2.27 years (min: 4- max:12). The number of patients in the classified groups according to the amounts of spherical equivalents, astigmatism and composed spherical equivalents and astigmatism are shown in Table 1, Table 2 and Table 3 respectively. The age when the visual defect was detected (p=0.16) and the duration of treatment (p=0.48) were not significantly different between the defined refractive groups (<4 D, 4-7 D, >7 D). Similarly the age when the visual defect was detected (p=0.16) and the duration of treatment (p=0.85) were not significantly different between patient groups defined according to the composed spherical equivalent and astigmatism.

Table 1. The frequency and percent of levels of spherical equivalents [in diopters(D)] observed in patients

Amount of spherical equivalent	n	%
No spheric refractive error	1	2.5
0-4 D of hypermetropia	19	48.7
4-7 D of hypermetropia	11	28.2
>7 D of hypermetropia	8	20.5
Total	39	100.0

Table 2. The frequency and percent of levels of astigmatism [in positive cylinder and in diopters (D)] observed in patients

Level of astigmatism	n	%
2 D	21	53.8
2-4 D	8	20.5
4-6 D	10	25.6
Total	39	100.0

Table 3. The number of patients classified according to composed spherical equivalents and astigmatism in diopters (D)

Levels of composed astigmatism and hypermetropia	n	%
<4D of hypermetropia and <2D of astigmatism (Group I)	10	24.4
>4D of hypermetropia and <2D of astigmatism (Group I)	13	31.7
<4D of hypermetropia and >2D of astigmatism (Group I)	11	26.8

The mean final and initial binocular BCVA values of patients with different levels of spherical equivalents are summarized in Figure 1. The initial binocular BCVA levels were significantly lower in patients with > 4 D of hypermetropia (p=0.028), but their final binocular BCVA levels after treatment with glasses were not statistically different compared to those with < 4 D of hypermetropia (p=0.235).

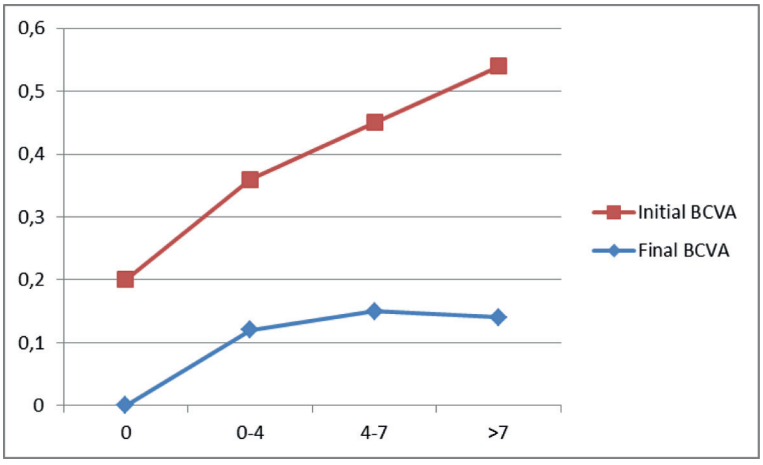

Figure 1. The mean final and initial binocular best corrected visual acuity (BCVA) values of patients with different levels of spherical equivalents.

The mean initial and final binocular BCVA levels of patients classified according to the amount of astigmatism in positive cylinder form are shown in Figure 2. The initial binocular BCVA levels were not significantly different between patient groups classified according to the amount of astigmatism (<2 D, 2-4 D, 4-6D of astigmatism), but the final mean BCVA levels were significantly lower in patients with 4-6D of astigmatism compared to the patients with 2-4 D of astigmatism (p=0.001). The difference between the other pairs (2D vs 2-4 D and 2D vs 4-6 D) were not significant (p>0.05).

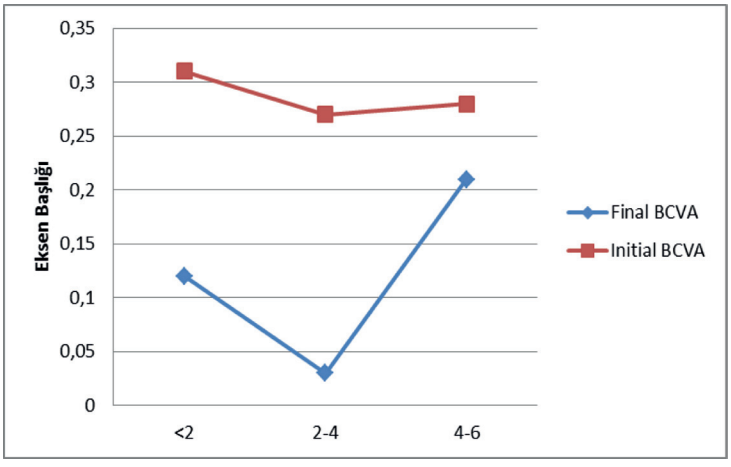

Figure 2. The mean initial and final binocular best corrected visual acuity (BCVA) levels of patients classified according to the amount of astigmatism in positive cylinder form.

For analysis of composed spherical and astigmatic refractive errors three groups [<4 D of hypermetropia and < 2 D of astigmatism (group I), > 4 D of hypermetropia and < 2 D of astigmatism (group II), and < 4 D hypermetropia and > 2 D of astigmatism (group III)] were in sufficient numbers to make statistical analysis. The mean initial and final binocular BCVA levels of the groups with composed hypermetropia and astigmatism are summarized in Figure 3.

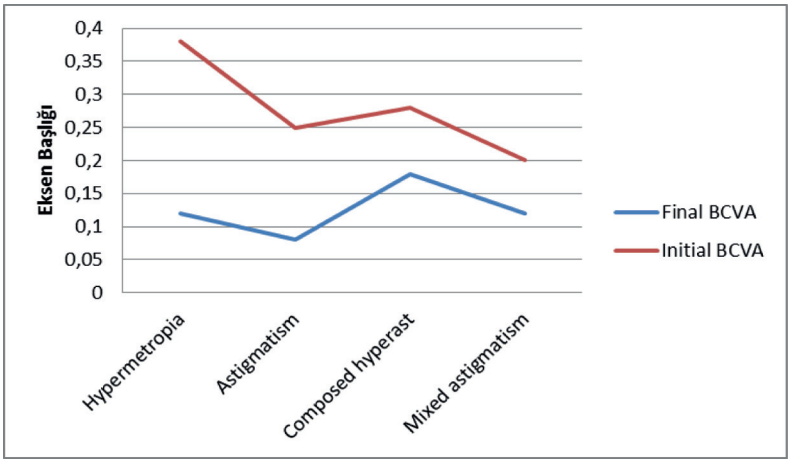

Figure 3. The mean initial and final binocular best corrected visual acuity (BCVA) levels of the groups with composed hypermetropia and astigmatism.

The initial binocular BCVA levels were significantly different between groups (p=0.02). Subgroup analysis by Mann Whitney U test revealed that group I had significantly higher mean initial binocular BCVA as compared to group II (p=0.015). The mean final binocular BCVA was not significantly different between groups I-III (p=0.35)

Table 4. The initial and final best corrected visual acuity (BCVA) levels of patients in LogMar units

BCVA level (LogMar)	Initial		Final	
	n	%	n	%
0	-	-	10	25.6
0.1	-	-	13	33.3
0.2	21	53.8	9	23
0.3	8	20.5	5	12.8
0.4	4	10.2	2	5.1
0.5	3	7.6	-	
0.6	2	5.1	-	
0.7	1	2.5	-	
Total	39	100	39	100

After treatment by correction of refractive error with glasses, the visual acuities and ratios of stereopsis were increased significantly in all of the patients at the final visit (p= 0.001 for each). The levels of initial and final binocular BCVA and stereopsis of patients are observed in Table 4 and Table 5 respectively.

Table 5. The initial and final stereopsis values in patients

Stereopsis (seconds of arc) by TNO	On admission		After treatment	
	n	%	n	%
00	20	51.2	10	25.6
60.00	-	-	5	12.8
120.00	3	7.6	8	20.5
240.00	5	12.8	10	25.6
480.00	7	17.9	3	7.6
Total	35	89.7	36	92.3
Not evaluated	4	10.2	3	7.6

DISCUSSION

Amblyopia, with a prevalence of 3.2 % in the general population is the most common cause of blindness under 45 years of age.[2] Bilateral amblyopia is relatively rarely reported as compared to other types of amblyopia with an incidence of 6-26% in patients with hypermetropia.[1-6] Bilateral refractive amblyopia develops in children with large amounts of uncorrected hypermetropia, astigmatism, or both.[3-5] In case of anisometropia the greatest amount of improvement in visual acuity is reported to be observed in myopes and the least in simple hyperopes.[3,7] However effects of different types of refractive errors in case of bilateral amblyopia remains to be defined. We aimed to evaluate visual acuity levels of the patients with bilateral amblyopia and different refractive properties.

Increased magnitude of the hyperopia has been shown to have the greatest influence on the visual acuity outcome both at initial correction of refractive error and 1 year or longer after correction in a younger patient population (mean age 3.97

years) with 5 D or more of isometropic hyperopia.[7] We found a significant difference in visual acuity between patients with lower (<4D) and higher levels (>4D) of hypermetropia before treatment with optical correction, but after treatment there was no significant difference between them. Similarly the difference in initial binocular BCVA between group I and group II reflects the difference in patients with high (> 4 D) and low (<4D) levels of hypermetropia. In this patient group with a relatively higher mean age (7.04±2.30, range 3-13) compared to other studies [3,7-8] (5 years 1 month -5.5 years) this good response in this patient group probably suggests extension of plasticity period in case of high hypermetropia.

Children with significant bilateral hypermetropia are reported to have greater binocular acuity improvement than those with significant bilateral astigmatism; however the cumulative probability of reaching 20/25 or better binocular acuity over one year is reported to be similar.[5] We found no significant difference in final BCVA levels between the group with high hypermetropia (group II) and that with high astigmatism (group III).

In the analysis of astigmatism, the final mean BCVA levels were significantly lower in patients with 4-6D of astigmatism compared to the patients with 2-4 D of astigmatism (p=0.001). While it is clear that optical treatment provides a significant benefit, some researches also demonstrated that there may be limits to plasticity related to optical correction of astigmatism-related amblyopia since astigmatic subjects did not attain normal levels of visual function.[8-9]

Duration of correction and the age of first correction also are reported to influence the visual acuity outcome,[5,9-12] in our study the age when the visual defect was detected (p=0.16) and the duration of treatment (p=0.48) were not significantly different between the defined refractive groups (<4 D, 4-7 D, >7 D). Similarly the age when the visual defect was detected (p=0.16) and the duration of treatment (p=0.85) were not significantly different between patient groups defined according to the composed spherical equivalent and astigmatism.

Obviously there are some limitations to our study. First the number of patients in some groups (patients with high hypermetropia and high astigmatism) were not enough for statistical analysis. Therefore the results do not include all refractive error groups.

The 9 patients among those patients with less than 4 D of hypermetropia had also less than 2 D of cylindrical refractive errors. The cause of amlyopia in these cases remains to be answered. The refractive status of the patients at presentation may not represent their previous refractive errors. This is an important possibility and can only be confirmed by future prospective cohort studies involving patients at lower ages. Underlying inability to accommodate normally affecting emmetropization in hypermetropic subjects maybe another factor for development of amblyopia as suggested.[8] The unknown natural history of amblyopia remains to be resolved.

Finally we think that lower levels of hypermetropia should also be evaluated cautiously as bilateral refractive amblyopia. The age at diagnosis and duration of treatment and the initial and final BCVA levels after treatment with optical correction seem not to be significantly different among patients with different types of refractive errors and also different levels hypermetropic errors. However the stereopsis ratios are lower with higher refractive errors. But larger cohort studies maybe needed for confirmation of these findings.

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