Original Article

Severity of Amblyopia and Its Correlation with The Amount of Refractive Error

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ABSTRACT

Background: *To analyze the correlation between the severity of amblyopia and the amount of refractive error*
Methods: *Patients in outpatient clinic dr Soetomo General Hospital, who was diagnozed as amblyopia, from November 2011 – January 2013, were enrolled in this retrospective study. All subjects were evaluated for subjective refraction using Snellen Chart and objective refraction using streak retinoscopy. The severity of amblyopia determined by the BCVA and the amount of refractive error stated by the spherical equivalent and the amount of cylindrical errors.*
Result: *The subjects of this study was 40 patients (73 eyes) with age 5-11 years old. The range of BCVA was 0,1-0,8 logMAR units, the spherical equivalent of refractive errors were minus 1,5D – 12,75D and the cylindrical errors were minus 0,50 – 5,00D. Statistically, there was correlation between the severity of amblyopia and the spherical equivalent of refractive errors, but there was no correlation with the cylindrical errors.*
Conclusion: *The severity of amblyopia has a correlation with the amount of spherical equivalent of refractive error, but has no correlation with the amount of astigmatism.*

Key words: *Amblyopia, Spherical Equivalent, Cylindrical Error*

Amblyopia, also referred by the public as "lazy eye", is a unilateral or, less commonly, bilateral reduction of best-corrected visual acuity that cannot be attributed directly to the effect of any structural abnormality of the eye or the posterior visual pathways. With a prevalence of 3-5%, amblyopia represents a major public health problem. In fact, amblyopia is the leading cause of monocular vision loss in the United States in people younger than 40 years (Yip,2007).

Amblyopia is caused by abnormal visual experience early in life resulting from one of the following: strabismus, anisometropia or high bilateral refractive errors (isometropia), and stimulus deprivation (Rouse et al 1994, Raab et al 2011, Gunawan 2012).

Refractive amblyopia happens when there is a large or unequal amount of refractive error (glasses strength) in a child's eyes. Usually the brain will "turn off" the eye that has more farsightedness or more astigmatism. Parents and pediatricians may not think there is a problem because the child's eyes may stay straight. Also, the "good" eye has normal vision. For these

reasons, this kind of amblyopia in children may not be found until the child has a vision test. This kind of amblyopia can affect one or both eyes and can be helped if the problem is found early.

Potentially amblyopiogenic refractive errors divided into two categories : isometropia (ametropia) and anisometropia. Anisometropic amblyopia develops when unequal refractive errors in the 2 eyes causes the image on 1 retina to be chronically de-focused. This condition is thought to result partly from the direct effect of image blur on visual acuity development in the involved eye and partly from interocular competition or inhibition similar (but not necessarily identical) to that responsible for strabismic amblyopia. Relatively mild degrees of hyperopic or astigmatic anisometropia (1.00-2.00D) can induce mild amblyopia. Mild myopic anisometropia (less than -3.00D) usually does not cause amblyopia, but unilateral high myopia (-6.00D or greater) often results in severe amblyopic vision loss (Rouse et al 1994, Raab et al 2011).

In isometropic (ametropic) amblyopia, a bilateral reduction in acuity that is usually relatively mild, results from large, approximately equal, uncorrected refractive errors in both eyes of a young child. Its mechanism involves the effect of blurred retinal images alone. Hyperopia exceeding about 5.00D and myopia in excess of 6.00D-8.00D carry a risk of inducing bilateral amblyopia. Uncorrected bilateral astigmatism in early childhood may result in loss of resolving ability limited to the chronically blurred meridians (meridional amblyopia). The degree of cylindrical ametropia necessary to produce meridional amblyopia is not known, but most ophthalmologists recommend correction of greater than 2.00D-2.50D of cylinder (Rouse et al 1994, Raab et al 2011, Gunawan 2012).

Patients with amblyopia may be debarred from undertaking certain jobs because they fail to meet the required visual standards and additionally they may be at risk of visual handicap if they should damage or lose the vision of the fellow eye (Adams et al 2003). And, until today, there was only little has been established about the association of refractive errors and degree of amblyopia (Ingram 1977). The purpose of this study was to analyze the correlation between the severity of amblyopia and the amount of refractive error .

METHODS

This was a retrospective observational study. We reviewed medical records of amblyopic children who came to outpatient clinic of dr Soetomo General Hospital from November 2011 – January 2013. Amblyopia here was defined as a patient having best corrected visual acuity less than 5/5 in subjective refraction using Snellen Chart.

The amount of refractive error was measured using Snellen chart if possible subjectively and with objective refraction using streak retinoscopy under cycloplegia and autorefractokeratometry and stated in spherical equivalent form. We also noted the amount of the cylindrical error if the patient had astigmatism and converted it to minus cylinder form. Anterior segments were examined using slitlamp biomicroscopy and posterior segment were examined using direct ophthalmoscope. We assessed as amblypia if the subject has BCVA less than 5/5 at least 1 line with no abnormality in anterior and posterior segment. We also excluded every subject with strabismus.

The severity of amblyopia were defined as the number of lines of Snellen chart that the patient couldn't read. We also excluded subjects who have different BCVA in both eyes for more than 1.50 DCyl astigmatisme, more than +1.00DS of hypermetropia and more than 3.00 DS of myopia, history of wearing glasses, history of previous acular suregry or history of amblyopia therapy.

We used Kolmogorov Smirnov Test and Spearman Correlation Test for statistical analysis and the data processed using SPSS 18.0 program. It was considered had statistical value if p<0.05.

RESULTS

Subjects

73 eyes from 40 patients were eligible for the criterias and enrolled in this study. The characteristics of the subjects was shown in table 1. From this table we could see that the range of the subject's age was 5-13 years old, with average 8.2 years. Five subjects had unilateral amblyopia and 35 subjects had bilateral amblyopia.

Table 1. Characteristics of the subjects

Age (years)	Unilateral (patient)	Bilateral (patient)	Total (eye)
5		2	4 (5.4%)
6	1	6	13(15%)
7		9	18(24%)
8		4	8(36%)
9	2	4	10(13.7%)
10	2	4	8(36%)
11		4	8(36%)
12		1	2(2,7%)
13		1	2(2.7%)
Total	5		73

Spherical Equivalent

From tabel 2 bellow, we found that 20 (27%) of the subjects had refractive error less than 3 Diopter Sphere in spherical equivalent form, 27 subjects (37%) had refractive error between 3–6 Diopter Sphere and 26 (36%) subjects had more than 6 Diopter Sphere of refractive error.
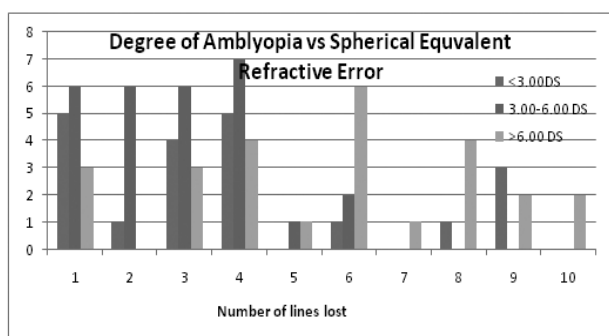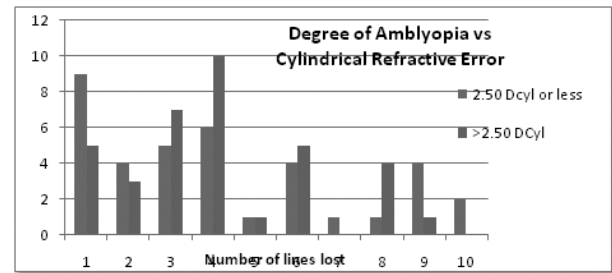
Tabel 2. Spherical equivalent

Spherical equivalent	n	%
less than 3DS	20	27
3-6DS	27	37
more than 6DS	26	36
Total	73	100

Cylindrical errors

The tabel 3 below revealed that 37 eyes or 50.1 % of the subjects had 2.50 Diopter Cylinder or less and 36 eyes or 49.9 % had more than 2.50 Diopter Cylinder. All above were in minus cylinder form.

Tabel 3. Cylindrical error

Cylinder	n	%
2.50 DCyl or less	37	50.1
more than 2.50 DCyl	36	49.9
Total	73	100

Fig 1. Degree of Amblyopia vs Spherical Equivalent Error

Fig 2. Degree of Amblyopia vs Cylindrical Refractive Error

Tabel 4. Degree of Amblyopia vs Refractive Error

Number of Lines Lost	Spherical Equvalent Refractive Error			Cylindrical Refractive Error	
	<3.00	3.00-6.00	> 6.00	≤ 2.50	>2.50
1	5	6	3	9	5
2	1	6	0	4	3
3	4	6	3	5	7
4	5	7	4	6	10
5	0	1	1	1	1
6	1	2	6	4	5
7	0	0	1	1	0
8	1	0	4	1	4
9	3	0	2	4	1
10	0	0	2	2	0
	20	28	26	37	36

Correlation with severity of amblyopia

The median of reduced best corrected visual acuity of the subjects was 4 lines from 5/5 with range from 1-10 lines.

From tabel 4 we could see that the subjects who lost 10 lines of Snellen chart had Spherical Equivalent RE >6.00 D were 2; and cylindrical RE ≤2.50 D were 2. The most subjects had SE RE 3-6 D (28) and cylincrical RE ≤2.50 D (37).

Statistical analysis using Spearman Correlation Test showed that there was a significant correlation between the amount of refractive error (in spherical equivalent form) and the number of lines that the subjects couldn't read ($p<0.05$) but there was no significant correlation between the amount of cylindrical error and the number of lines that the subject couldn't read ($p<0,05$).

DISCUSSION

Subjects

In this study, the subjects were 5-13 years old. This wide range made us difficult to isolated the magnitude of refractive error as single factor

that influenced the development of amblyopia. We didn't have any record how long the subject had his ametropia, or how the progression was. Amblyopia happened by conditions that occur at an age at which the integrity of the visual system is susceptible to modification of visual experience. Although this time period varies in individual patients, clinical experience indicates that it ranges from birth to approximately 4- to 5 years of age for all forms of amblyopia (von Noorden, 1974) and the worse initial visual acuity, the longer left uncorrected the worse also the final visual acuity found (Levartovsky et al, 1995).

We excluded subjects with different BCVA in both eyes for more than 1.50 DCyl astigmatisme, more than +1.00DS of hypermetropia and more than 3.00 DS of myopia to rule out the present of anisometropia as confounding factor for the occurence of refractive amblyopia (Rouse, 1994).

Spherical Equivalent and Amblyopia

We classified the subjects' refractive error to three categories : <3.00 Diopter Sphere to represent mild degree of ametropia, 3.00-6.00 Diopter Sphere as moderate degree of ametropia and >6.00 diopter sphere as high degree of ametropia (Goss et al, 1997). From tabel 2 we got relatively equal in the numbers of subject who had mild ametropia (27%), moderate ametropia (37%) and high ametropia (36%).

From tabel 4 we could see that in each degree of ametropia there was variability in the degree of amblyopia. In subjects with mild ametropia the number of lines that they couldn't see was vary from 1 line to 9 lines, in subjects with moderate ametropia the degree of amblyopia was 1 line to 6 lines and in subjects with high ametropia they lost 1 line to 10 lines. This was similar with the theory that Patients with isoametropic amblyopia have a wide range of visual acuity loss, from slightly worse than 20/20 to 20/200 (Rouse et al 1994). But it was statistically significant correlation ($p<0.05$) in the degree of amblyopia and the degree of ametropia. It meant that the higher the refractive error the higher the degree of amblyopia. Interestingly, we found here that any degree of ametropia could cause amblyopia in the absence of anismetropia. It was slightly different with common theory

that hypermetropia greater than 5.00DS and myopia greater than 8.00 D are common causes of isoametropic amblyopia (Rouse, 1994).

Cylindrical Error and Amblyopia

We classified the subjects' cylindrical error as two categories : $\geq$ 2.50 DCyl and >2.50 DCyl to differentiate low degree and high degree of astigmatism and astigmatism considered to cause amblyopia if >2.50 Dcyl (Rouse et al, 1994) or >3.00 (Gunawan, 2012). Here we had almost similar in number of subjects who had low degree astigmatism (50,1%) and high degree astigmatism (49.9%).

From tabel 4 we revealed that in subjects with low grade astigmatism they had various degree of amblyopia from 1 line to 10 lines and in subjects with high degree of astigmatism the degree of amblyopia also varied from 1 line to 9 lines. It meant that any degree of cylindrical error could induced amblyopia. And it was statistically no significant correlation between the amount of cylindrical refractive error and the degree of amblyopia ($p<0.05$). It was different from many previously studies that showed the higher the astigmatism the higher the degree of amblyopia and astigmastism which at risk of developing amblyopia was the high degree one (Rouse et al, 1994;Yip et al, 2007; Dobson et al, 2008; Gunawan, 2012). May be it was because there was only a little studies about refractive amblyopia without anisometropia and here we limited to review subjects without anisometropia to purified the role of the amount refractive error and cylindrical error.

CONCLUSION

There was significant correlation between the severity of amblyopia and the amount of Spherical Equivalent but there was no correation between the severity of amblyopia and the amount of cylindrical refractive error.

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