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Effect of Amblyopia Patch Therapy on Visual Acuity and CSF of Children

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Amblyopia is a common childhood vision disorder with a prevalence of 1.6-3.5% worldwide. It has different causes such as anisometropia, strabismus and visual deprivation. This study aimed to determine the effect of patching operation of the better eye on visual acuity (VA) and contrast sensitivity function (CSF) of the amblyopic eye. Thirty four children (18 boys; 16 girls) with mean age of 6.88±1.48 (SD) years participated in the study. Twenty six children had anisometropic and eight had combined (anisometropia and strabismus) amblyopia. VA and CSF of the subjects were measured through YANG vision tester before and three months after patching therapy.The VA between both eyes and CSF at four spatial frequencies, 1.5,6, 12 and18 cycles per degree (cpd) in two phases, were compared. In the better eye, the best corrected VA did not show any significant difference before and after treatment. In amblyopic eyes, postoperative VA significantly improved (P<0.001). Furthermore, the postoperative CSF at high and low spatial frequencies did not show statistically significant difference, whereas at the medium levels significantly increased(P=0.003, 0.001).VA increased in 64% participants and CSF improved 1.16, 1.57, 3.91 and 2.44 times in 1.5, 6, 12 and 18 spatial frequencies respectively. Complete (VA 20/20) and relative improvement (at least 2 lines) of VA was achieved in 60.61% and 39.39% of amblyopic cases respectively. Based on our results, patching of the better eye in amblyopic children can improve VA and CSF, especially in intermediate frequencies. Therefore, our findings recommend the CSF as an accompanying and complementary test for VA at pre and post patch operation evaluation in amblyopia treatment.

Key words: Children, Amblyopia, Visual Acuity, Contrast Sensitivity Function.

Amblyopia is a common childhood vision disorder a prevalence of 1.6-3.5% worldwide. It has different causes such as anisometropia, strabismus and visual deprivation[1]. Amblyopia reduces visual acuity (VA) and contrast sensitivity function (CSF). VA measure is used for ability of eyes to see small details where as CSF is used for larger details. In other words, VA and CSF could be interpreted as quantitative and qualitative sight assessment, respectively. In daily life, sensitivity of CSF is in practice 3 to 5 times more than VA for various functions[2]. CSF has a stronger correlation with grating visibility than optotype[3]. In amblyopia, patients may report a vision of 20/20 (Zero in Log Mar scale) or a fully recovered case,whereas CSF is significantly different with the normal eye[4].Under low vision conditions (VA<0.9 Log Mar), CSF reduces even more indicating significant correlation with visual acuity (r=-0.72).However, under better vision conditions (VA>0.9 Log Mar), CSF indicates lower reduction with no significant correlation (r=-0.19) and even sometimes functions like normal level[1]. While in strabismus amblyopia CSF reduces

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at high frequencies (13- 30 cpd), in anisometropic amblyopia it reduces at all frequencies (0.6- 30 cpd) but once amblyopia is fully recovered then it becomes tangible at all frequencies[5-6]. A question recently has raised is that once full visual acuity, 20/20 vision,is achieved, could amblyopic case be considered as recovered?Or, are there other factors like CSF should be considered to achieve full recovery? Regarding high occurrence of amblyopia and its treatment age restriction, conducting similar studies is necessary.

YANG vision tester is used to measure visual acuity,either the grating type or optotype, and CSF simultaneously and it is approved by FDA in United States. The device using in the present study is recently entered the market and electronically conducts all the relevant visibility tests for various distances and spatial frequencies, with the capability of drawing diagrams and in a steadyambient lighting (135 cd/m²). Through the present study we examined the effect of patching the better eye on visual acuity and CSF of amblyopic eye among amblyopic children referred to the Imam Hossein center (Tehran, Iran)during 2010-2011within all frequency range, further, the correlation between visual acuity and CSF within different amblyopic groups (strabismus, anisometropic, and combined) was also examined.

METHODS

This quasi-experimental clinical trial was conducted on 39 children with unilateral amblyopic eye. Four children were excluded from the study because they had bilateral amblyopia and couldn't meet the study prerequisites. Moreover, one of them didn't refer for checkup. Therefore, the study carried out with 34 eligible children and the following methods were applied.Further to the parents' consents and a form containing demographic information such as age, gender and etc. comprehensive eye tests including cyclo refraction (refractive examination under cycloplegicdrops) were conducted by auto refractometer. In next stage, the Best Corrected VA (BCVA) was measured based on Log Mar scale with YANG vision tester based on optotype signs. CSF was measured in both eye's single eye examination for all frequencies in the same way. Average test ambient lighting was 135 cd/m². Muscle movement examinations and Cover test (the test to detect strabismus) as well as fixation was conducted for each child attending the study. To track eye pathological diseases, full anterior and posterior eye parts examinations with flashlight and ophthalmoscope were conducted for all children. Throughout the present study, a minimum of 2 line differences between two eyes on the sign chart is considered amblyopia, and equal or greater than one diopter refraction differences between the two eyes is considered anisometropic either in sphere or cylinder level. Moreover, eye strabismus greater than 10 prism was interpreted as strabismus amblyopia.The word "Combined" is applied for cases which simultaneously exhibit both amblyopia and strabismus.Furthermore , for a period of one to three months (minimum one week per each age year) the normal eye was daily patched for two, four, and six hours depending on amblyopic severity level of mild, moderate, and severe with vision acuity of 20/30, 20/100, and 20/200 respectively. Both eye visions were checked monthly until both eyes' vision equaled or at least two lines of improvement on Log Mar scale was indicated in amblyopic eye. Further to necessary patching, all the sample children were re-examined andVA and CSF differences were determined before and after three months. Mean and standard deviation were applied for data description. Paired T test was applied to compare the values before and after the test. Pierson correlation coefficient was applied to find the correlation between VA improvement and contrast sensitivity. Covariance analysis was applied to compare post-recovery VA and CSF with the normal eye while pre-treatment values and intervening variables have being taken into consideration as auxiliary variables.

RESULTS

The study was conducted on a sample group of 34 children aged between 4 to 10 years, over a period of 10 years. The demographic data is shown in table 1. (Table 1)

The assessment doesn't indicate any VA differences with the normal eye, before and after the recovery. However, CSF exhibits an increase at high frequencies (18cpd) which is presented in table 2.(Table 2)

Table 3 demonstrates the main stage of the

Table 1. Basic demographic and physical characteristics of the participants

Variable Type	Basic Characterization	
Age	*6.9*±1.5 with age range of 4 to 10 years old	
Sex	18 (52.9%) boy	16(47.1%) girl
Spherical Refractive	Right eye Diopter 1.58±0.44	Left eye Diopter 2.11±0.41
Refractive astigmatism	Right eye Diopter -1.04±1.0	Left eye Diopter -0.85±0.16
Amblyopia	34 unilateral (100%) – No bilateral	
Amblyopic Type	26 Anisometropia (76.5%) 0 Strabismus (0%)- 8 mixed cases (23.5%)	
Ocular aberration	*Far:4 Isotropia (11.8%) - 4 Exotropia (11.8%)- No vertical deviation*	
	Near: 5 Isotropia (14.7%) - 3 Exotropia (8.8%)- No vertical deviation	
Treatment Duration	3 months	

Table 2. Pre- and postoperative comparisons of the normal eye VA and CSF. Values are presented in average ± SD

Variable Type	Mean±Standard Error		%95 Confidence Interval	P-Value
	Before	After	for Mean Differences	
Visual acuity(Log Mar)	0.040±0.011	0.037±0.10	(-0.007,-0.002)	0.325<
Contrast sensitivity function (percentage)				
Frequency 1.5 CPD	158.52± 7.48	162.1± 4.41	(-14.58, 22.46)	0.688
frequency 6 CPD	181.23 ±10.64	193.9 ± 8.95	(-12.60, 37.27)	0.321
Frequency 12 CPD	73.85±11.24	86.03 ± 11.11	(-7.12, 30.33)	0.216
Frequency 18 CPD	15±4.52	27.84±5.66	(2.05, 26.67)	0.024

Table 3. Pre- and post-operative comparisons between VA and CSF of amblyopic eyes

Variable Type	Mean±Standard Error		P-Value
	Before	After	
Visual acuity (Log Mar)	0.370 ± 0.025	0.133± 0.025	<0.001
Contrast sensitivity function (percentage)			
Frequency 1.5 CPD	116.5 ± 10.94	134.8± 9.75	0.162
Frequency 6CPD	96.3 ± 14.08	151.5 ± 11.95	0.003
Frequency 12 CPD	14.2 ± 4.98	55.5 ± 9.80	0.001
Frequency 18 CPD	7.3 ± 3.14	17.8 ± 4.27	0.078

Table 4. Pre- and post-operative comparisons between VA and CSF of amblyopic eyes

Variable Type	Mean±Standard Error		P-Value
	amblyopic eyes	True eyes	
Visual acuity(Log Mar)	0.370±0.025	0.011 ± 0.040	<0.001
Contrast sensitivity function (percentage)			
Frequency 1.5 CPD	116.5 ± 10.94	158.5 ± 7.48	0.002
Frequency 6 CPD	96.3 ± 14.08	181.2 ± 10.64	<0.001
Frequency 12 CPD	14.2 ± 4.98	73.8 ± 11.24	<0.001
Frequency 18 CPD	7.3 ± 3.14	15.0 ± 4.52	0.166

Table 5. Pre- and post-operative comparisons between VA and CSF of normal eye with amblyopic eyes

Variable Type	Mean±Standard Error		P-Value*	P-Value**
	amblyopic eyes	True eyes		
Visual acuity (Log Mar)	0.133 ± 0.025	0.037 ± 0.010	0.009	0.808
Contrast sensitivity function (percentage)				
Frequency 1.5 CPD	134.81 ± 9.75	162.12 ± 4.41	0.037	0.207
Frequency 6 CPD	151.54 ± 11.95	193.90 ± 8.95	0.112	0.222
Frequency 12 CPD	55.48 ± 9.80	86.03 ± 11.11	0.982	0.426
Frequency 18 CPD	17.81 ± 4.27	27.84 ± 5.66	0.219	0.527

* T test was applied to compare the values for amblyopic eyes and true ayes
** Covariance analysis to compare post-recovery VA and CSF with the normal eye

study which is a comparison between amblyopic eye's pre and post treatment values. According to table 3 there is a significant difference between pre and post treatment values (P<0.001). CSF variable was measured at 4 various frequencies[1.5, 12, 6, and 18]. Although signs of improvement are reported at high and low frequencies (1.5 and 18 cpd), there is no significant changes in these points. On the other hand,a serious change is observed at intermediate frequencies (6 and 12 cpd) which indicate the greater impact of this treatment in these regions (p=0.003 for 6 cpd) and (p=0.001 for 12 cpd). (Table 3)

According to table 4, pre-treatment VA and CSF comparison between normal and amblyopic eye indicates significant variation for all cases excluding 18 CPD frequency.

Although post-treatment VA and CSF comparison between normal and amblyopic eye indicated vision and CSF improvement at all frequencies, there were still differences in visibility level and CSF at 1.5 cpd frequency.Covariance analysis was applied to assimilate pre-treatment conditions. For instance, as table 4 indicates the differences between normal and amblyopic eyes prior to treatment at 1.5 CPD; normal and amblyopic eye indicate 158.5 and 116.5, respectively. Covariance analysis was conducted to eliminate the impact of pre-treatment differences and their impact on post-treatment vaiations. It is assumed that prior to treatment; normal and amblyopic eyes were similar,so any post-treatment changes remain intact with no confounding effect of initial values.(Table 4)

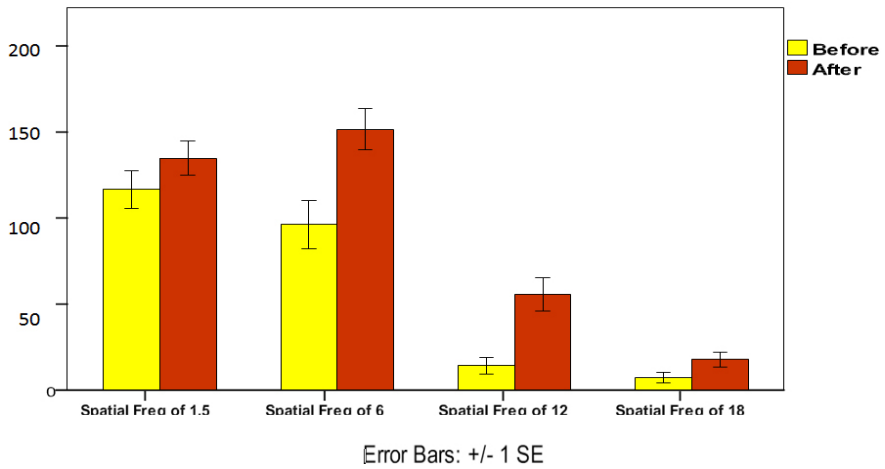

Diagram 1. Shows the CSF of amblyopic eyes before and after treatment at various frequencies.

Table 5, clearly indicates that only CSF at 1.5 frequency had significant changes (p=0.037) which eliminates by adjusting to pre-treatment values; Therefore, these results reflect children better eye patching treatment impact on both VA and contrast sensitivity. (Table 5)

Diagram 1 indicates CSF changes in the recovering eye at all frequencies which particularly indicates significance for 6 cpd and 12 cpd frequencies. (Diagram 1)

DISCUSSION

Based on the results of the present study, the better eye patching method was effective to treat VA and contrast sensitivity. As the results shows, the impact of this method was totally significant for improving VA (p-value=< 0.001). Most conducted studies indicate very good results by patching the normal eye, thus patching treatment has been taken into consideration[1,3,5,7-10]. For instance, (Koskela, 1990) reported that CSF has a stronger correlation with grating visibility than optotype[3]. During the present study, we applied advanced YANG vision tester, letter type vision chart and Log Mar scale.

Treatment by patching the better eye increases amblyopic eye's CSF at all tested frequencies (1.5 cpd, 6 cpd, 12 cpd, and 18 cpd) However, the highest effects are indicated at intermediate frequencies of 6 and 12 cpd (p=0.003, 0.001). Despite upward changes at low and high frequencies like 1.5 cpd, and 18 cpd, they are not as intense as intermediate frequencies and not statistically significant.

(Sjostrand, 1981) reported through his studies that strabismus amblyopia reduces contract sensitivity at high frequencies (13- 38 cpd), and in anisometropic amblyopia contract sensitivity reduces at all frequencies (1.4- 38 cpd). However, it will improve at all frequencies once amblypoia is fully recovered[5]. Moreover, (Levi and Harwerth, 1977) reported CSF reduction at all frequencies in anisometropic amblyopia patients and verifies our results on anisometropic amblyopia part[11]. (Hesse and Hawell, 1977) indicated CSF reduction at all frequencies in their studies on strabismus amblyopia patients which is aligned with the overall results of this study[12]. (Heravian *et al*, 2009) suggest that CSF is more susceptible to visional changes, thus patching better eye in amblyopia treatment results in more tangible outcomes on CSF than VA[8]. Therefore, for cases in which visual changes could not be assessed based on VA measurement, it would be possible to see the changes by measuring contrast sensitivity and it is useful for early diagnosis[8].

This method of treatment increases VA as much as 64%. Moreover, CSF at 1.5 cpd, 6 cpd, 12 cpd, 18cpd frequencies increased up to 1.16, 1.57, 3/19, 2/44 times, respectively. This study reports 60.61% full vision recovery (20/ 20), and 39.39% partial vision improvement (minimum 2 lines vision increase). Finally, amblyopic and normal eyes are compared and the results are presented in table 5. However, there were significant changes between VA and CSF at 1.5 cpd which was not reported after applying covariance analysis to adjust the base line. This point indicates the effect of patching the normal eye of children on both VA and contrast sensitivity.

There are necessary points to outline

According to table 2, beside an increase in CSF after patching the normal eye, it could also be an indicative CSF simultaneous increase in both normal and amblyopic eyes.

CSF significant differences at 1.5 cpd could be indicative for post amblyopia treatment slight CSF differences in low frequencies.

In terms of constraints, we faced lack of full cooperation from some children even at age 4 to 5, whom we had to exclude at commence of the study. The second point is that our target group was children with unilateral amblyopia and no previous treatment. Therefore, all the participating children were undergoing amblyopia treatment for the first time that led to an increasing number of patients in the target group and was another form of limitation we had to encounter. The main strength of this study is to use YANG vision tester since it is capable to measure both VA and CSF variables at the same time and place with fixed distance and steady ambient lighting, in high velocity and fully digital. Particularly the velocity of the tests prevents children of being exhausted and inaccurate

CONCLUSION

The results of the present study indicates that patching the normal eye causes VA improvement and CSF increase at all spatial

frequencies particularly intermediate frequencies. It is recommended that CSF test to be applied as a side and complementary test to treat amblyopia

REFERENCES

1. Moseley, M.J., Stewart, C.E., Fielder, A.R., Stephens, D.A., Intermediate spatial frequency letter contrast sensitivity: its correlation to visual resolution before and during amblyopia treatment. *Ophthalmic Physiol Opt,* 2006. **26**(1): p. 1-4.
2. Lew, H., Han, S.H., Lee, J.B., Lee, E.S., Contrast sensitivity function of sound eye after occlusion therapy in the amblyopic children. *Yonsei Med J,* 2005; **46**(3): 368-71.
3. Koskela, P.U., Alanko, H.I., Correlations between visual acuity, grating acuity and contrast sensitivity in amblyopia. *Acta Ophthalmologica,* 1990; **68**(S195): p. 91-3.
4. Rogers, G.L., Bremer, D.L., Leguire, L.E., The contrast sensitivity function and childhood amblyopia. *Am J Ophthalmol*, 1987; **104**(1): p. 64-8.
5. Sjostrand, J., Contrast sensitivity in children with strabismus and anisometropic amblyopia. A study of the effect of treatment. *Acta Ophthalmol* (Copenh), 1981; **59**(1): p. 25-34.
6. Bradley, A., Freeman, R.D., Contrast sensitivity in anisometropic amblyopia. *Invest Ophthalmol Vis Sci*, 1981; **21**(3): 467-76.
7. Zhou, Y., Huang, C., Xu, P., Tao, L., Qiu, Z., et al., Perceptual learning improves contrast sensitivity and visual acuity in adults with anisometropic amblyopia. *Vision Res,* 2006; **46**: 739–750.
8. Heravian, J., Mahjoob, M., Khabbaz-khoob, M.,Ostadi-Moghaddam, H., Khalafi, A.,Yekta, A.A., Effect of occlusion therapy on visual Acuity, contrast sensitivity and streopsis in amblyopia. *Bina Ophtalmol,* 2009; **14**(2): 130-134.
9. Abrahamsson, M., Sjostrand, J., Contrast sensitivity and acuity correlation in strabismus and anisometropic amblyopia. *Br J Ophthalmol,* 1988; **72**(1): p. 44-9.
10. Campos, E.C., Prampolini, M.L., Gulli, R., Contrast sensitivity differences between strabismus and anisometropic amblyopia: objective correlate by means of visual evoked responses. *Doc Ophthalmol,* 1984; **58**(1): p. 45-50.
11. Levi, D.M., Harwerth, R.S., Spatio-temporal interactions in anisometropic and strabismus amblyopia. *Investigative Ophthalmology & Visual Science,* 1977;**16**(1): p. 90-5.
12. Hess, R.F., Howell ,E.R., The threshold contrast sensitivity function in strabismus amblyopia: evidence for a two type classification. *Vision Res*, 1977. **17**(9): p. 1049-55.