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Research Article

Does Four Hours Per Day of Occlusion Influence the Visual Function of the Non-Amblyopic Eye?

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Abstract

Patching is an important method for the treatment of amblyopia, but inappropriate patching will cause the impairment of the visual function. This study is to explore the impact of four hours per day of patching on the visual function of the patient's sound eye-21 amblyopes (treated with spectacles and patching four hours per day, the patching group) and 6 amblyopes (treated with spectacles only, the control group) were enrolled in our study. Visual acuity of the amblyopic eye exhibited significant improvement after one month of four hours per day of patching. Increased contrast sensitivity of the non-amblyopic eye of the patching group was shown at the 6.0cpd after one month and 3 months ($P = 0.004$; $P = 0.016$) under photopic conditions, only after three months ($P = 0.037$) under scotopic conditions. But, compared to the control group, the contrast sensitivity of the non-amblyopic eye of the patching group only showed significant difference at the 6.0cpd after three months of treatment ($P = 0.045$). No matter whether it was one month or three months after patching, the non-amblyopic eye did not cause a statistical difference in visual acuity. The results above showed that four hours per day of patching does no harm to the visual function of the patient's sound eye.

Keywords: *Non-Amblyopic Eye; Contrast Sensitivity; Amblyopic Eye; Visual Acuity*

Abbreviations

AE: Amblyopic Eye; NAE: Non-Amblyopic Eye; CS: Contrast Sensitivity

Introduction

Amblyopia, the commonest visual disorder of childhood in Western societies, affects, predominantly, spatial visual function. A period of refractive correction followed by covering the non-amblyopic eye for varying daily durations is of great importance for the treatment of amblyopia [1]. Even two-four hours per day of occlusion of the sound eye with vision training through near visual tasks of the amblyopic eye (AE) is effective [2]. However, inappropriate occlusion will lead to the decreased visual function of the non-amblyopic eye (NAE).

Visual acuity testing, the current gold standard in the assessment of vision, only provides a limited amount of information under artificial conditions. However, contrast sensitivity testing is a powerful tool for determining the capability of the visual system, which processes spatial and temporal information about the everyday objects. It could measure a range of visual performance under real-life conditions that could contain amounts of contrast and give us a more complete quantification of patients' visual capabilities [3]. Contrast means a measure of the amount of lightness or darkness in comparison to its background. Compared to visual acuity, contrast sensitivity (CS) can

better reflect the visual function of patients [4]. So this study is performed to explore the influence of four hours per day of occlusion on the visual function of the sound eye through contrast sensitivity, not only visual acuity.

Materials and Methods

Research protocol was approved by the Ethics Committee of Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology. The informed consents about the follow-up examination were obtained from all the patients. All experiments were performed in accordance with the Declaration of Helsinki.

Participants: 21 amblyopes (male 13; female 8. mean, 7.29 years; SD, 2.452 years) were treated with spectacles and patching for four hours per day in Tongji Hospital from 18-November-2013 to 20-August-2014; 6 amblyopes (male 3; female 3; mean, 8.83 years; SD, 3.189 years; used as control, treated with spectacles only) were also enrolled in our study. They all had refractive errors and no ocular deviation, no non-centric fixation, no deprivation, no nystagmus, and no surgical history. They all could understand and coordinate our research. The spherical equivalent of the amblyopic eye and the non-amblyopic eye (the patching group) was 5.02 ± 3.020 DS and 2.64 ± 1.819 DS, respectively.

Measurements of Visual Function: After mydriasis with Atropine and optometry, all patients were given maximum plus to maximum visual acuity (MPMVA). The Traditional Snellen Eye Chart (Precision Vision, La Salle, Illinois, USA) was employed for the visual test, of which the background brightness was 80 ~ 320 cd/m^2. The 1.0 lines of the chart are at the same height with the eyes, and it is 5 meters away from the subject's eyes to the chart.

The US Stereo Company OPTEC® 6500 visual function tester is used to conduct the Functional Acuity Contrast Test (FACT), which selects sinusoidal gratings as contrast sensitivity testing standards. The brightness of the tests is 85 cd/m^2 (light) and 3 cd/m^2 (dark). The sinusoidal grating spatial frequencies were 1.5 cpd, 3.0 cpd, 6.0 cpd, 12.0 cpd, and 18.0 cpd to test the right and left eyes, respectively. Test Method: turn on the remote switch, repeat 5 # to 9 # test pictures followed by testing the bright mode on Day button and then the dark mode on Night button. If the answer is correct, proceed to the next test picture until there is an incorrect answer, and then record the last correct answer [5].

The data were analyzed by the Statistical Package for Social sciences (SPSS) software (Version 19.0).

Results

The effects of the therapy on best corrected visual acuity

There existed no statistical difference between the patching group and the control group on best corrected visual acuity change after one month and three months of treatment. After 1 month (P = 0.363) and three months (P = 0.363) of treatment, the best corrected visual acuity of the NAE showed no difference from that before treatment (Table 1).

	Spherical equivalent	Before	1 month	3 month
Patching group	2.64 ± 1.819	1.00 ± 0.206	1.00 ± 0.236	0.97 ± 0.188
Control group	1.44 ± 2.16	0.97 ± 0.234	0.93 ± 0.201	0.90 ± 0.167

Table 1: *The best corrected visual acuity and spherical equivalent of the two group.*

The effects of the therapy on contrast sensitivity of the patching group

The photopic condition table 2 and figure 1A exhibited the change of the contrast sensitivity of the patching group before and after patching under the photopic condition. After one and three months of patching, the contrast sensitivity demonstrated no difference at the

1.5 cpd, 3.0 cpd, 12.0 cpd, 18.0 cpd spatial frequencies (P = 0.228, 0.299, 0.943, 0.478; P = 0.971, 0.178, 0.879, 0.334). But, it displayed statistical difference at the 6 cpd spatial frequencies (P = 0.004; P = 0.016).

	Ap	Bp	Cp	Dp	Ep
Before	59.81 ± 31.215	102.52 ± 52.328	90.57 ± 50.611	47.71 ± 33.935	22.67 ± 21.903
1month	70.05 ± 29.852	115.57 ± 45.391	117.43 ± 52.026	64.95 ± 40.605	19.43 ± 18.750
3month	60.10 ± 26.681	118.48 ± 32.469	120.71 ± 47.775	49.14 ± 28.290	18.29 ± 13.398

Table 2: *The contrast sensitivity of the patching group under the photopic conditions.*

Ap, Bp, Cp, Dp, Ep mean photopic environment space frequency 1.5, 3, 6, 12, 18 cpd, respectively.

The scotopic condition table 3 and figure 1B exhibited the effects on the contrast sensitivity of the patching group before and after patching under the scotopic condition. After one month of patching, the contrast sensitivity had no statistical difference at the 1.5 cpd, 3.0 cpd, 6.0 cpd, 12.0 cpd, 18.0 cpd (P = 0.797, 0.108, 0.112, 0.884, 0.811). What is more, after three months of patching, the contrast sensitivity also has no difference at 1.5 cpd, 3.0 cpd, 12.0 cpd, 18.0 cpd (P = 0.548, 0.298, 0.779, 0.887). But, the contrast sensitivity revealed obvious difference at 6cpd (P = 0.037).

	As	Bs	Cs	Ds	Es
Before	71.33 ± 27.139	102.14 ± 36.336	72.62 ± 42.653	32.71 ± 30.453	10.43 ± 14.201
1 month	72.76 ± 29.567	116.95 ± 45.892	93.43 ± 64.711	33.76 ± 36.023	11.52 ± 17.497
3 month	75.05 ± 25.711	112.24 ± 42.701	99.00 ± 60.208	35.14 ± 36.200	11.10 ± 15.732

Table 3: *The contrast sensitivity of the patching group under scotopic condition.*

As, Bs, Cs, Ds, Es mean scotopic environment space frequency 1.5, 3, 6, 12, 18cpd, respectively.

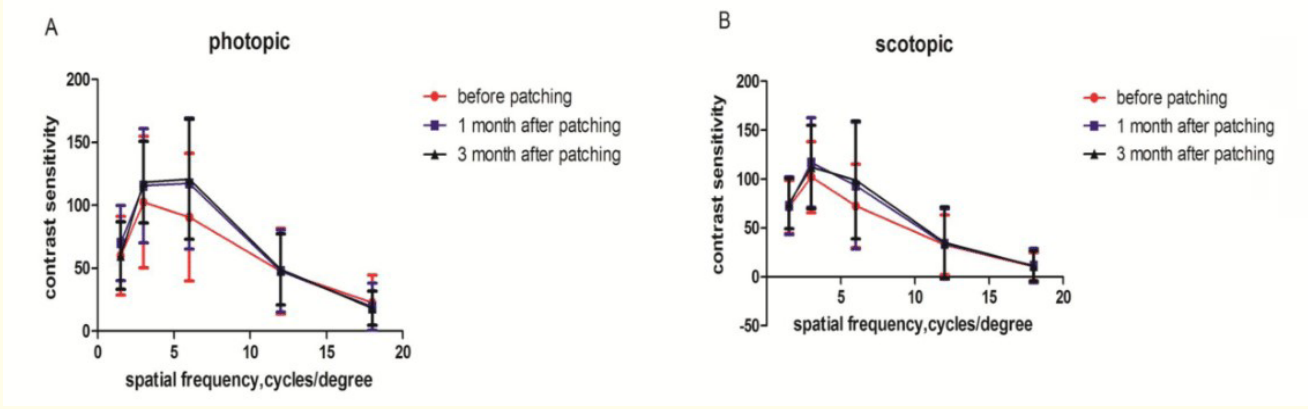

Figure 1: *The contrast sensitivity function before and after patching under the photopic and scotopic conditions. A: The contrast sensitivity showed statistical difference at the 6cpd spatial frequencies after 1 and 3 months of patching (P = 0.004; P = 0.016). B: The contrast sensitivity only revealed obvious difference at 6cpd after 3 months (P = 0.037). Error bars show 95% Cls. The p values < 0.05 were considered significant.*

The difference between the patching group and the control group

There is no difference between the patching group and the control group at all spatial frequencies after 1 and 3 months of treatment both under the photopic and scotopic conditions except at the 6.0cpd after 3 months of treatment under the scotopic conditions (P = 0.045).

Discussion and Conclusion

Amblyopia is a neurological disorder of binocular vision that affects up to 3% of the population resulting from a disrupted period of early visual development [6]. Disturbance of sensory experience that shapes brain connectivity in its developmental time can cause permanent dysfunction of the visual system. Abnormal visual experience that can lead to asymmetry of the visual inputs shifts the visual cortical neurons in fond of the sound eye and enduring deficiency of the weak eye [7]. Patching is an important way to make the amblyopic eye involuntary. Patching treatment is based on the closure of the healthy eye in order to make the patient use the weak eye and stimulate the amblyopic eye for vision. Thus, it could help and reshape the part of the brain that manages vision so that it develops more completely [8].

So far, doubts about the role of patching on the CS of the non-amblyopic eye during the treatment of amblyopia do exist. Helen Lew found that the vision remains the same during patching, and although the bright environmental CS had no statistical change, the dark environmental CS significantly decreased. So, the study suggested the cover will lead to CS damage of the healthy eye [9]. However, some scholars believed that amblyopia treatment had no significant effect on the non-amblyopic eye CS. Klio I Chatzistefanou found that the CS of the amblyopic and fellow eyes in amblyopia patients were lower than the normal control group, although it has increased during patching. The non-amblyopic eye after covering during the treatment, compared with the uncovered treatment of the non-amblyopic eye, did not show statistical difference [10].

Our study suggested that four hours a day of patching on the non-amblyopic eye did not cause decreased visual acuity of the covered eye, and showed improved contrast sensitivity of the non-amblyopic eye at the middle spatial frequency under the scotopic condition. It might be understood as follows: Our visual systems are more sensitive to feature what we expect (relative to not expect), making us focus on more informative features [11]. Mostly spatial frequency objects are in the natural environment, and amblyopia patients have a significant degree of plasticity in the visual system [12]. For the early detection of visual acuity deficits, mesopic contrast sensitivity can be considered to be a useful tool [9]. So, in our study, through the cover treatment, the patient's contrast sensitivity improved at the middle spatial frequency under the scotopic condition.

There is growing evidence that abnormal binocular interactions play a key role on amblyopia [13]. In particular, stronger interocular suppression of the amblyopic eye has been associated with poorer amblyopic eye visual acuity [14]. Moreover, reblancing the interocular suppressive interactions is critical for the effective treatments that can improve not only monocular, but also binocular visual function [15,16]. The asymmetric interocular suppression in amblyopic vision is a consequence of the asymmetric gain-control energy of the two eyes. Typically, the dominant eye's gain-control energy is comparable to normal, but the non-dominant eye (NDE)'s gain-control energy is much reduced [17]. In the visual system of amblyopia patients, the asymmetry of the two eyes can be rebalanced through regulating the relative luminance or the contrast of the two eyes at a given contrast and spatial frequency. Perhaps this is the reason that the CS has improved. Four hours per day of patching does no harm to the visual function of the patient's sound eye.

Competing Financial Interests

The authors declare that they have no competing financial interests.

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