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Research Article

Therapeutic Effects of CAM Visual Stimulation in 7 - 20 Years Old Patients with Amblyopia

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Abstract

Background: Since the age of patients directly influence in the treatment of amblyopia, and the results are not satisfactory after 7 years of age. The aim of this study was to evaluate the effectiveness of CAM visual stimulation in amblyopia treatment for 7 - 20 years old patients.

Methods: This study was conducted on 68 patients with amblyopia between ages of 7 to 20 years, randomly assigned to two groups: CAM visual stimulation and conventional occlusion. In CAM visual stimulation group (n = 34), participants were treated according to the amblyopia intensity in regular process to reach vision improvement over a 4 - 6week period. In conventional occlusion group (n = 34), the patients treated by using part time occlusion (4 - 6 hours daily) for a 12 - 14week period. Patients was assessed at 1, 2, and 3 months after initial visit.

Results: After 3 month follow up, visual acuity increased 0.26 ± 0.16 log MAR in the CAM visual stimulation group ($P < .001$) and 0.10 ± 0.12 log MAR in the conventional occlusion group ($P < .001$). Visual acuity of subjects in CAM visual stimulation group improved 0.54 ± 0.11 log MAR, 0.24 ± 0.10 log MAR, and 0.13 ± 0.04 log MAR respectively in severe, moderate, and mild groups with amblyopic patients ($P < .001$). In occlusiosn group, results were 0.32 ± 0.18 log MAR, 0.10 ± 0.12 log MAR, and 0.04 ± 0.04 log MAR respectively in severe, moderate, and mild groups with amblyopic subjects ($p = .56$). Also, there is no correlation between age and visual improvement in both groups ($P = .87$).

Conclusion: Patients older than 7 years old have good chance to achieve successful treatment of amblyopia by this method. CAM visual stimulation could be suggested to patients with severe amblyopia.

Keywords: Amblyopia; Occlusion Therapy; CAM Visual Stimulation

Introduction

Amblyopia is the most common cause of visual loss in children, affecting 2 - 3% of population [1]. There are several passive and active methods to treat amblyopia. Occlusion of the dominant eye and forced use of the amblyopic eye is the most common method and the best treatment [2]. One of alternative methods for amblyopia therapy based on grating stimuli is known CAM visual stimulation. This method firstly introduced by Campbell consists of high-contrast repetitive grating patterns with defined spatial frequency that slowly rotate and stimulate the visual system [3]. The past studies by using of CAM visual stimulation in treatment of amblyopia showed improvement of visual acuity and stereopsis in amblyopic children. In the patients with bilateral amblyopia, CAM visual stimulation improved visual acuity and had good compliance [4-7]. In some studies, CAM visual stimulation was mentioned as a useful alternative instead occlusion cannot be used [8-9]. Contrast sensitivity following CAM visual stimulation improved significantly, most notably at high frequencies [10]. Age of onset of treatment directly affects the outcomes. Once children reach the age 7 years improvement rate of visual acuity becomes very slow and compli-

ance with wearing a patch often becomes a major problem. In older ages, occ; usion method could be effective if done correctly, but it is hard work and needs motivation [11].

In recent years, several studies evaluated the efficacy of different methods of treatment (dichoptic training, perceptual learning, and video gaming) for amblyopia in older children [12-15]. Also, several studies using occlusion therapy in adults, in conjunction with refractive correction and near-vision activities, reported increases in visual acuity [16-18]. Modified virtual reality technology in amblyopia treatment had hopeful results [19]. Longitudinal studies indicated that the combination levodopa-carbidopa of and occlusion improved visual function in these patient [20].

In studies, the adult brain has been shown to be much more plastic than it was once believed to be. New findings in of sensory deprivation amblyopia, recovery was slow and incomplete in adult visual cortex [21-23].

The purpose of this study was to evaluate the efficacy of CAM visual stimulation method in improvement of amblyopia in older patients who have no success with other methods or lost golden time for treatment.

Materials and Methods

This randomized single blind study was performed in the optometry group of Shahid Beheshti University of Medical Sciences under the principles of Helsinki declaration. In this study, amblyopic patients in the age range of 7 to 20 were recruited from a private optometry/ ophthalmology clinic in Gillan-e-Gharb, Iran, in 2017. The diagnosis of amblyopia was made on basis of anisometropia amblyopia (a reduction in visual acuity (VA) due to presence of refractive error difference of greater than 1 diopter (D)), and strabismic amblyopia (a reduction in VA due to presence of any type of strabismus at least 15 prism diopters in the alternate cover test) and mixed amblyopia (anisometropia plus strabismic). All participants were healthy and without ophthalmological and systemic diseases. They had no history of amblyopia treatment in the last year. Exclusion criteria consisted of bilateral amblyopia, ocular diseases and history of ocular surgery. Type of treatment and patient performance were illustrated to all patients and their parents. For patients younger than eighteen years of age, parental consent was obtained. The oral consent was obtained in the presence of a third party. Patients were randomly divided into two therapy groups: the first CAM visual stimulation group and the other conventional therapy group. All patients had received a comprehensive ophthalmic examination. Objective retinoscopy was performed by retinoscope Beta 200 (Heine, Germany) and autorefractometer (Topcon Medical Systems, KR 800). Subjective refraction was performed by an experienced optometrist. The visual acuity was determined by a Digital Chart Tumbling E chart (Snellen chart). The VA was recorded in decimal notation and then converted to Log MAR (Minimum Angle of Resolution). According to initial BCVA, amblyopia was categorized into three levels: mild (VA between 0.15 - 0.3 log MAR), moderate (VA between 0.3 - 0.55 log MAR), and severe (VA ≥ 0.55 log MAR) [11].

Conventional therapy group and CAM therapy group were two models of treatment considered for the patients. In conventional therapy group, which was conducted outside the office, the patients were recommended to patch the no amblyopic eye 4 - 6 hours daily for a period of 12 - 14 weeks. Furthermore, near activities such as playing computer games was recommended during the patching 4 - 6 hours. A follow up visit was recommended after 1st, 2nd, 3rd months of the initiation of therapy. A six months follow up was recommend after the completion of therapy. In CAM visual stimulation group, after visual acuity assessment, the patients were trained with CAM visual stimulator (Shoae tadbir novin Co., Iran). The patients watched a high contrast square wave grating rotating plate, with spatial frequency 1 line higher than patient detection, while drawing on the transparent disk for 20 minutes. At the end of each session, amblyopic eye was was lit by red light (560 nm) flash of CAM device for 4 minutes. At all times of treatment, the other eye was occluded. If VA improved, plates with high spatial frequency was selected in following visit. In a period of 4 - 6 weeks, each patient had 2 - 3 sessions weekly. If no improvement of vision observed after 4 sessions, this modality was discontinued. All examinations were repeated 1, 2, and 3 months after treatment.

Any change in mean VA in 3rd follow up visit was considered as the primary outcome measure. Statistical analysis of our data was performed by SPSS software version 18. The results were statistically analyzed using oneway Anova and kruskal wallis test.

Results

Sixty eight subjects (34 male and 34 female) with mean age of 12.14 ± 6.14 (range 7 - 20) years participated in this study. Twelve patients had strabismic amblyopia, and thirty eight patients had anisometropic amblyopia and eighteen patients had mixed amblyopia. The mean spherical equivalent was +2.20 ± 5.13 D with range - 19.00 to +9.50 D. In the first CAM visual stimulation group, the baseline visual acuity was 0.37 ± 0.19 log MAR and improved to 0.15 ± 0.18 log MAR and 0.12 ± 0.18 log MAR and 0.11 ± 0.18 log MAR in the first, second, and third month after treatment. IN the occlusion group, the mean BCVA was 0.40 ± 0.17 log MAR firstly and improved to 0.32 ± 0.18 log MAR and 0.31 ± 0.17 log MAR and 0.30 ± 0.17 log MAR in the first, second, and, third months post-treatment. These results showed improvement of 0.26 ± 0.16 log MAR in CAM visual stimulation group ($P < .001$) and 0.10 ± 0.12 log MAR in the other group ($P < .001$) (Table1). While vision increased 1 - 2 lines in 8 patients (24%) in CAM visual stimulation group and 12 eyes (35%) in occlusion group but increased > 2 Snellen

lines in 25 eyes (73%) in CAM visual stimulation group and 6 eyes (18%) in occlusion group. Also, one person in CAM visual stimulation group and sixteen patients (47%) in the other group had no improvement.

In details, visual acuity of subjects in CAM visual stimulation group improved 0.23 ± 0.07 log MAR, 0.23 ± 0.14 log MAR, and 0.30 ± 0.22 log MAR respectively in strabismic, anisometropia, and mixed subjects. In occlusion group, vision improved 0.11 ± 0.12 log MAR, 0.07 ± 0.09 log MAR, and 0.14 ± 0.14 log MAR respectively in strabismic, anisometropia, and mixed amblyopic patients. Our results did not show statistically significant difference in vision improvement between strabismic and anisometropia patients in CAM visual stimulation group (p = .85) and occlusion group (p = .30).

According to amblyopia intensity patients divided into three group including severe, moderate, and mild amblyopia. Visual acuity of subjects in CAM visual stimulation group improved 0.54 ± 0.11 log MAR, 0.24 ± 0.10 log MAR, and 0.13 ± 0.04 log MAR respectively in severe, moderate, and mild groups with amblyopic patients. In occlusion group, results were 0.32 ± 0.18 log MAR, 0.10 ± 0.12 log MAR, and 0.04 ± 0.04 log MAR respectively in severe, moderate, and mild groups with amblyopic subjects (Table2). Accurate comparison between groups and type of treatment showed statistically significant different in vision improvement within several groups of patients in CAM visual stimulation group (P < .001) but did not it in occlusion group (p = .56) (Table3).

Group	Baseline	First month	2th month	3th month
Group 1 (CAM)				
Total (=34)	0.37 ± 0.30	0.15 ± 0.18	0.13 ± 0.18	0.12 ± 0.18
Strabismic (n=4)	0.26 ± 0.13	0.05 ± 0.48	0.03 ± 0.56	0.32 ± 0.56
Anisometropic (n=23)	0.33 ± 0.18	0.13 ± 0.11	0.10 ± 0.10	0.09 ± 0.10
Mixed (n=7)	0.53 ± 0.55	0.25 ± 0.34	0.24 ± 0.34	0.23 ± 0.35
Group 2 (Occulosion)				
Total (=34)	0.41 ± 0.18	0.32 ± 0.18	0.31 ± 0.17	0.30 ± 0.17
Strabismic (n=8)	0.46 ± 0.16	0.38 ± 0.19	0.35 ± 0.18	0.35 ± 0.17
Anisometropic (n=15)	0.37 ± 0.18	0.28 ± 0.17	0.29 ± 0.15	0.29 ± 0.15
Mixed (n=11)	0.41 ± 0.16	0.30 ± 0.18	0.28 ± 0.18	0.27 ± 0.19

Table 1: Mean ± SD of LogMAR visual acuities at baseline and during study.

Group	Baseline	3th month	P Value
Group 1 (CAM)			
Total (=34)	0.37 ± 0.30	0.15 ± 0.18	0.55
Severe (n=10)	0.86 ± 0.40	0.32 ± 0.33	
Moderate (n=18)	0.36 ± 0.14	0.11 ± 0.10	
Mild (n=6)	0.14 ± 0.41	0.02 ± 0.02	
Group 2 (Occulosion)			
Total (=34)	0.41 ± 0.18	0.32 ± 0.18	0.00
Severe (n=7)	0.84 ± 0.17	0.65 ± 0.33	
Moderate (n=19)	0.41 ± 0.13	0.32 ± 0.18	
Mild (n=8)	0.16 ± 0.42	0.13 ± 0.29	

Table 2: Mean ± SD of LogMAR visual acuities at baseline and during study according to amblyopic severity.

Group	Group 1(CAM) Total (=34)	Group 2 (Occulosion) Total (=34)	P Value
Sever (n=17)	0.54 ± 0.11	0.19 ± 0.25	0.31
Moderate (n=37)	0.24 ± 0.10	0.10 ± 0.12	0.00
Mild (n=14)	0.13 ± 0.04	0.04 ± 0.04	0.01

Table 3: Mean ± SD of LogMARVision improvement after 3 months.

Assessment of results showed there was no correlation between age and visual improvement in both groups (P = .87). During follow-up visits, all patients in the first group were pleased and happy and told this method was comfortable and suitable for daily programs. Vision increased in short duration and compliance of patients was excellent. In the second group, most of patients were unhappy and some of them said patching had interfered with their daily activities.

Also, forty eight patients had 6 months eye examination. Visual acuity were 0.07 ± 0.09 log MAR in CAM visual stimulation group and 0.32 ± 0.18 log MAR in other group (P < .001) (Table4).

Group	Baseline	6th month	P Value
Group 1 (CAM)			
Total (=25)	0.37 ± 0.30	0.07 ± 0.09	0.878
Strabismic (n=4)	0.33 ± 0.16	0.08 ± 0.10	
Anisometropic (n=14)	0.33 ± 0.18	0.10 ± 0.10	
Mixed (n=7)	0.53 ± 0.55	0.10 ± 0.09	
Group 2 (Occulosion)			
Total (=23)	0.40 ± 0.17	0.32 ± 0.18	0.902
Strabismic (n=3)	0.46 ± 0.13	0.33 ± 0.19	
Anisometropic (n=15)	0.37 ± 0.18	0.35 ± 0.14	
Mixed (n=5)	0.41 ± 0.17	0.28 ± 0.21	

Table 4: Mean ± SD of LogMAR visual acuities 6 months after treatment.

Discussion

While for many investigators, younger children were subjects for the field of amblyopia treatment this study was conducted in patients of 7 - 20 years old. Our results indicated that visual acuity could be improved in amblyopic patients older than 7 years old and the rate of improvement is not related to age of patients. Holmes in a meta-analysis on relationship between age and amblyopia stated better response to treatment occured among children younger than age 7 years. Although, the rate of improvement was lower in 7 - 13 years old, but some of them showed a marked response to treatment [22]. Mintz-Hittner in a study on 36 children older than 7 years stated occlusion therapy for amblyopia could be successful even initiated after age 7 years [23]. Park in a study on 16 patients of 9 years or older showed that occlusion therapy had successful outcomes in these patients [23]. These findings provide evidences that the modification of neuronal processes at the primary visual cortex continues even after that age of seven.

In according to severity of amblyopia, vision of our patients in CAM therapy group increased more than the other group and the rate of improvement was highest in the severe cases. Visual acuity in CAM group increased five lines versus two lines for the occlusion group. Pediatric Eye Disease Investigator Group compared full-time patching with 6 hours patching per day in children younger than 7 years with severe amblyopia. Both methods of patching showed similar improvement by 4.7 lines in children 3 - 7 years of age [25]. Irfan in a clinical trial evaluated 115 cases with unilateral severe amblyopia using full-time occlusion therapy. She noted more than 90% of patients in the 13 - 35year group achieved to complete VA, but reversal of amblyopia occurred in two cases [26].

Our result indicated that the rate of improvement of visual acuity in CAM group was twice the rate of the occlusion group. Some patients had sixth month follow-up and their vision did not show recurrence of amblyopia in both groups. In older subjects, less improvement in occlusion group could be due to less compliance with patching outside the office. The positive reinforcement of therapist in CAM therapy sessions and appropriate visual task for the amblyopic eye could affect the better results in this group. In confirmation of our findings, Huang has noted a satisfactory outcomes with CAM vision stimulator in most instance bilateral amblyopia younger than seven [6]. Jafari in a clinical trial in 40 children aged 4 to 6 years old, compared conventional occlusion therapy with occlusion therapy plus complementary CAM visual stimulation. He stated CAM therapy along with occlusion 2 - 6 hours daily would further improve visual acuity and stereopsis in amblyopic children [5]. CAM treatment for amblyopia in 15 children from 5 to 12 years was evaluated by Tytla. He stated that vision changes could be attributed to the short-term occlusion experienced by all subjects during treatment and that grating stimulation did not contribute to this improvement [27]. Also, Doba indicated that the pattern stimulation was not responsible for changes in vision [4]. But other some studies have shown improvements in contrast sensitivity following treatment with the CAM therapy [2,28,29]. Kampf studied computer-based and supplement occlusion therapy in 55 patients beyond childhood during a period of 6 months. The visual acuity was increased about two logarithmic steps by an occlusion combined with computer training that was about twice as effective as the preceding occlusion alone [30]. Our study showed more improvement with CAM therapy in older children. In older subjects due to more active social role and inability to patch the good eye in performing many tasks, CAM offers a better treatment modality than occlusion. The compliance of the patients with the patching regimen out of office was one of the limitations of this study. There was no way to know how long exactly the patch was worn by the patient other than their own report. The other limitation was inability to blind the patient to the treatment. Two types of therapy had to be clearly explained the patients in order to achieve optimum results.

In conclusion, in the age range of 7 - 20year, CAM visual stimulation method was more effective than conventional occlusion method. The rate of improvement in severe type of amblyopia was more significant with the CAM therapy. Given that occlusion is not

socially acceptable for older children or younger adults, CAM offers a good alternative to conventional method. Patching in the severe group can also induce a great disability in performing different tasks, CAM visual stimulation may be offered as a better therapy mode to avoid disability. We suggest to provide a mobile Application by CAM visual stimulation base for easy treatment in home.

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