Brief Report

Anaglyphic Three-Dimensional Movie: A Simple Binocular Method to Treat Anisometropic or Strabismic Amblyopia in Adults

Arash Mirmohammadsadeghi[1], Motahhareh Sadeghi[1], Abolfazl Kasaee[1], Mohammad Reza Akbari[1]

[1]Eye Research Center, Farabi Eye Hospital, Tehran University of Medical Sciences, Tehran, Iran

Abstract

Purpose: To evaluate the efficacy of anaglyphic three-dimensional movies to treat adults with anisometropic or strabismic amblyopia.

Methods: This is an interventional case series. The seven cases were put on a trial frame containing subjective refraction, fogging plus lenses for the dominant eye, correcting prism, and anaglyphic red-cyan plastic spectacles. Patients participated in 20 sessions of 1.5 h of anaglyphic three-dimensional animated movie watching in the office. Significant visual acuity (VA) improvement was defined as improvement ≥0.2 in logMAR values. Change in octaves of stereopsis was defined as halving the arcsec or 0.3 change in log arcsec.

Results: The average age was 26.9 ± 10.0 (16–42) years. The mean VA in amblyopic eye improved significantly from 0.42 ± 0.19 (0.15–0.7) logMAR to 0.25 ± 0.15 (0.1–0.5) logMAR after completion of sessions ($P = 0.02$), and four cases showed significant VA improvement. The mean stereoacuity improved significantly from 2.6 ± 0.3 (2.1–2.9) log arcsec to 2.1 ± 0.5 (1.7–2.9) log arcsec ($P = 0.04$). Four cases showed ≥2 octaves improvements in stereopsis.

Conclusion: A simple and readily available method of amblyopia treatment can be effective in some adult cases.

Keywords: Adult amblyopia, Anaglyphic three-dimensional movies, Binocular amblyopia treatment

Address for correspondence: Mohammad Reza Akbari, Eye Research Center, Farabi Eye Hospital, Tehran University of Medical Sciences, Tehran, Iran.
E-mail: mrakbari83@hotmail.com
Submitted: 01-Apr-2021; **Revised:** 03-Dec-2021; **Accepted:** 09-Dec-2021; **Published:** 16-Apr-2022

Introduction

The binocular treatment strategies for amblyopia such as dichoptic perceptual learning and dichoptic three-dimensional and virtual reality movies (passive treatment) or action and nonaction games (active treatments) showed promising results in recent research.[1] The only problem is that some of the binocular exercises need special types of equipment. The purpose of the present study was to evaluate the effects of watching simple, readily available anaglyphic movies on the visual function of adults with anisometropic or strabismic amblyopia.

Methods

This interventional case series was compliant with the principles of the Declaration of Helsinki. The Ethics Committee of Tehran University of Medical Sciences approved the study design with the ethics code of IR.TUMS.FARABIH.REC.1400.024. All participants signed the written informed consent. The study was done in the strabismus and amblyopia clinic of Farabi Eye Hospital. Inclusion criteria were age 16 years or older, mild-to-moderate amblyopia in one eye (0.7≥logMAR>0.1 in the amblyopic

Access this article online

Quick Response Code:

Website: www.jcurrophthalmol.org

DOI: 10.4103/joco.joco_101_21

How to cite this article: Mirmohammadsadeghi A, Sadeghi M, Kasaee A, Akbari MR. Anaglyphic three-dimensional movie: A simple binocular method to treat anisometropic or strabismic amblyopia in adults. J Curr Ophthalmol 2022;34:124-7.

eye and difference between two eyes >0.1 logMAR), and strabismic, anisometropic, or combined (strabismic and anisometropic) types of amblyopia. Participants were considered anisometropic if the difference in refraction between two eyes exceeded 1.5 diopter (D) sphere or 1.5 D cylinder and were considered strabismic if a positive history of strabismus surgery was present or any tropia was revealed in the cover test and was considered combined if both the conditions were present. Patients with a lack of binocularity potential (such as dissociated vertical deviation or latent nystagmus), patients with no stereopsis, patients with a history of intraocular surgery other than strabismus, and patients with other ocular conditions that can affect visual function such as macular disease, glaucoma, lens opacities, and severe amblyopia (logMAR>0.7) were excluded from the study.

Visual acuity (VA) was measured using one logMAR chart at 6 m by one optometrist blinded to the study purpose. The optical correction was prescribed at least 4 months before the treatment sessions in all patients since optical correction alone has improved VA to an even normal range in teenagers and adults.[2] Data at the beginning of treatment sessions were considered as baseline data in the analysis. Stereoacuity was also measured by one orthoptist blinded to the study purpose, using Titmus test at 40 cm with refraction on the trial frame and near correction, if needed, and polarized glasses.

The participants had to watch 20 movies in total (30 total h) in the office, broken down into two 1.5-h-sessions a week (3 h a week). While watching movies, patients were put on a trial frame containing their subjective refraction plus fogging lenses (+3.00 to + 4.00) in front of the dominant eye to decrease VA to equal or 0.1 logMAR more than the amblyopic eye. We confirmed binocular viewing by asking the patient if he or she saw both color sets on the screen. When a deviation was present, the correcting loose prisms were also added to the trial frame. They were also instructed to put on plastic red-cyan glasses, with a red filter for one eye and a cyan filter for the other, over the trial frame. Due to color influences on suppression and the impact on contrast, the amblyopic eye always wore the red filter. In the meantime, the monitor plays the movie with an anaglyphic three-dimensional effect so that each filter sees one image and makes a relatively three-dimensional viewing.

We presented 20 popular animated feature movies in three-dimensional format on a monitor in the 40 cm distance from the eyes. However, instead of using special monitors and three-dimensional glasses, we used an open-source software (VLC media player, 2.2.4 Weatherwax) and put the video play setting on a simple bi-color anaglyphic view, projected into an ordinary image monitor. With this method, two images from a slightly different view angle, but otherwise identical, were presented, which were conceived separately by each eye due to different colors of images and glasses, creating a three-dimensional view. In this method, both eyes see the whole scene, and with fogging the better eye, the depth and resolution of images for both eyes are nearly balanced. Having both eyes see the same image to enhance binocular fusion is one of the significant differences of our strategy with other binocular treatments (dichoptic or virtual reality-based movies and video games).

Some questions were asked at the end of the movie to ensure complete watching. The participants had their VA and stereoacuity tested before starting treatment, after 15, 23, and 30 h of watching movies, and 6 months after completion of sessions.

To present data, we used mean ± standard deviation (range) and frequency (percentage). Significant VA improvement was defined as improvement ≥0.2 in logMAR values (for example, from 0.7 to 0.5). Data for stereopsis were also transformed to log arcsec for analysis. Stereopsis improvement was also presented as the change in octaves (halving the arcsec or 0.3 change in log arcsec) to assess the significance of improvement.[3] Wilcoxon signed-rank test was used to compare the results before and after treatment. The analysis was conducted using SPSS statistics version 24 (IBM, New York, USA). $P < 0.05$ was considered statistically significant.

Results

Nine amblyopic patients entered the study. Seven cases (2 males [28.6%]) with an average age of 26.9 ± 10.0 (16–42) years completed the treatment course. Only the data of these participants were considered in the analysis. Three patients had an uncorrected refractive error or needed new glasses administered at least 4 months before starting the sessions. The VA in the sound eye was 20/20 in all cases. The data for refraction and strabismus condition of patients, as well as prescribed refraction for both eyes and prescribed trial prisms for residual strabismus in strabismic cases, are presented in Table 1. No side effects such as drowsiness or headache were seen during or after the treatment sessions.

The mean VA in amblyopic eye improved significantly from 0.42 ± 0.19 (0.15–0.7) logMAR to 0.25 ± 0.15 (0.1–0.5) logMAR after completion of sessions ($P = 0.02$) (mean improvement in logMAR of 0.17 ± 0.13). All patients except one responded to the treatment in terms of VA improvement. However, only four cases showed significant VA improvement [≥0.2 logMAR change, Table 2].

The mean stereoacuity improved significantly from 2.6 ± 0.3 (2.1–2.9) log arcsec to 2.1 ± 0.5 (1.7–2.9) log arcsec ($P = 0.04$). Five cases (71.4%) showed improvements in stereopsis, including three cases with significant VA improvement [Table 2]. In four of five cases who showed an improvement in stereoacuity, a change of ≥2 octaves was observed, which can be considered a result of the treatment process and not test–retest variability.

VA improvement was continued from 23 to 30 h of treatment in three cases [Table 2: Cases 1, 2, and 6]. The improvement in stereopsis was continued from 15 to 23 h of treatment in three

Table 1: Refraction and strabismus characteristics of the cases

Sex	Age	Type	Refraction of the amblyopic eye	Refraction of the sound eye	Additional fogging lens	Prims included in the trial frame	Previous surgery	Deviation (with glasses)
Male	22	Anisometropic	+3.00-5.00×20	Plano	+3.50	None	None	Ortho
Female	33	Combined	+5.50-1.50×150	Plano	+4.00	6 PD BO	None	6 PD RET
Female	35	Strabismic	−0.50-0.75×95	Plano	+3.00	4 PD BO	Recess-resect for ET	4 PD LET
Female	42	Anisometropic	+5.50-0.75×60	+1.00	+4.00	None	None	Ortho
Female	16	Strabismic	+1.75-2.5×170	+1.50-2.50×25	+3.00	6 PD BI	Recess-resect for XT	6 PD RXT
Female	24	Anisometropic	−12.00	−0.50-0.50×170	+3.50	None	None	Ortho
Male	16	Strabismic	+2.50-2.50×175	+3.00-2.75×175	+3.00	6 PD BO	None	6 PD LET

PD: Prism diopter, BO: Base-out, BI: Base-in, ET: Esotropia, XT: Exotropia, RET: Right esotropia, LET: Left esotropia, RXT: Right exotropia

Table 2: Demographic characteristics and pre and posttreatment data of the cases

Sex	Age	Type	Initial logMAR	LogMAR at 15 h	LogMAR at 23 h	LogMAR at 30 h	Initial stereo	Stereo at 15 h	Stereo at 23 h	Stereo at 30 h	Change in octave
Male	22	Anisometropic	0.5	0.3	0.3	0.15	200	80	50	50	2
Female	33	Combined	0.7	0.7	0.7	0.5	800	140	140	140	>2
Female	35	Strabismic	0.4	0.1	0.1	0.1	140	60	60	60	<2
Female	42	Anisometropic	0.15	0.15	0.1	0.1	400	140	60	60	>2
Female	16	Strabismic	0.2	0.2	0.2	0.2	400	140	80	80	>2
Female	24	Anisometropic	0.5	0.5	0.4	0.3	800	800	800	800	0
Male	16	Strabismic	0.5	0.4	0.4	0.4	400	400	400	400	0

cases [Table 2: Cases 1, 4, and 5]. However, the treatment beyond 23 h did not provide any additional improvement in stereopsis.

No other treatment was performed between the end of the study and the 6-month follow-up. We observed no decline in achieved VA and stereopsis after 6 months of stopping treatment sessions.

Discussion

Our results demonstrated that even the simplest nonactive binocular visual exercises could improve VA, and more importantly, stereopsis in some adults. To our knowledge, no study evaluated anaglyphic movie watching as a binocular exercise in adults with amblyopia. Recent studies documented the effectiveness of binocular treatments on various visual functions in children with amblyopia, even as a primary treatment or in residual amblyopia after conventional monocular treatments.[4-6] Binocular designing of video games in an anaglyphic fashion has had comparable effects with more complicated designs.[7]

Most amblyopia treatment studies in adults reported an average of 0.1–0.25 logMAR increase in VA and 0.18–0.6 log arcsec improvement of stereopsis, using different binocular approaches.[7-12] In our study, like the previous ones, we showed an average of 0.17 logMAR improvement in VA and 0.5 log arcsec improvement in stereopsis. In our analysis, in four of five cases who showed an improvement in stereoacuity, a change of ≥2 octaves was observed, which can be proof for the significance of the results and efficacy of the treatment.

Binocular treatments proved to work for a short duration of 10 h and can affect visual function positively and relatively stable.[7,8,11,13] In the present study, although some positive effects were seen in the first 15 h of treatment [Table 2], VA improvement was continued until 30 h of treatment in some cases. Hence, our method may need more treatment hours to achieve full effect than other binocular treatments.

In 6 months of follow-up, no significant decline in our cases achieved VA, and stereoacuity was observed. Stability of the results of binocular treatments has also been shown in previous studies, even up to 1-year follow-up, without additional or reminder sessions.[1,11,14]

The main limitations of our study were the small number of patients and lack of a control group.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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