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Research Article

Outcome of New Computer Based Binocular Vision Therapy in Residual Amblyopia – A Pilot Study

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Abstract

Aim: To assess the efficacy of dichoptic therapy in the management of residual amblyopia.

Methods: In this prospective cohort study, children aged ≥ 6 years or adults with isoametropic (inter eye acuity difference of ≥ 2 lines), anisometropic or strabismic residual amblyopia were treated with 6 hours/week of office therapy (group 1) and 2 hours/day patching or 5 hours/week of home therapy (group 2) sans patching were evaluated after 6 weeks of therapy.

Results: In the office therapy group; 16 eyes of 11 children were included. 5 had bilateral (one eye more affected) and 6 had unilateral (anisometropic/strabismic/mixed) amblyopia. Mean age was 12.5 years. Mean improvement in bilateral amblyopia (n = 10) was 0.26, $p < 0.01$ (paired t test) and in unilateral amblyopia (n = 5) it was 0.28, $p = 0.05$. Maximum improvement in bilateral amblyopia was 0.48 (5 lines on logMAR chart) and in unilateral was 0.6 (6 lines). 4 patients with age > 18 years experienced mean 2.5 lines improvement. In home therapy group, seven eyes of seven patients aged 6 - 15 years were included. Five had strabismic amblyopia and 2 had anisometropic amblyopia. The best corrected vision improved in all with a mean 1.8 lines improvement (range 1 - 3 lines).

Conclusion: The new dichoptic therapies are promising treatment for patients with residual amblyopia. The office therapy along with part time patching was more effective than home therapy. Further studies are needed to identify the long-term efficacy of these therapies.

Keywords: *Binocular Vision; Dichoptic Therapy; Amblyopia*

Introduction

Amblyopia has 1-5% population prevalence and remains the commonest cause of monocular blindness in age group 20 - 50 years [1-4]. Next to refractive error, amblyopia is an ophthalmic disorder with the best opportunity-cost. The conventional treatment for unilateral amblyopia is still the occlusion therapy or patching. However, there are at least 6 major limitations with this therapy.

1. Residual Amblyopia [5]
2. Poor compliance [6-8]
3. Poor response in older children and adult amblyopes [9]
4. Recurrence after cessation of treatment [10]
5. Lack of improvement in the visuomotor skills, binocular fusion, stereopsis and ocular motility deficits viz. saccades and pursuits [11]
6. Slow improvement despite of long patching hours and good compliance [5,12].

1. In amblyopia treatment study (ATS) 2A [5] in a comparison of 6 hours versus full time patching, among the children aged 3 - 7 years with severe amblyopia, more than 85% patients had residual amblyopia of > 2 lines after 4 months of maximum patching.

2. Next to the age, compliance is the single most important determinant of outcome of amblyopia therapy [6]. The compliance to patching is reported to be 50% in age group > 5 years in the PEDIG study [7]. Highest reported compliance to patching among children is 70% [8].
3. In ATS 3 [9], less than 50% children aged 7 years to 17 years responded to patching (47% in < 12 years and 25% in 12 - 17 years groups) event when they had never done any patching in the past. Most patients, including those who had an improvement with patching were left with major residual visual acuity deficit [9].
4. Approximately one fourth (24%) of successfully treated amblyopic children experience a recurrence within the first year after cessation of the treatment [10]. Even with maintenance patching, 8 - 10% will have > 1 line drop in the visual acuity [10].
5. Multiple residual deficits in binocularity (fusion and stereopsis), hand eye coordination (fine motor skills) and ocular motor deficits (saccades, pursuits) are present in children with amblyopia and all of them a negative impact on the vision related quality of life in the affected individuals [11].
6. In ATS 2A [5] (6 hours/day versus full time patching for severe amblyopia) [5] and ATS 2B [12] (6 hours/day versus minimal 2 hours/day patching for mild or moderate amblyopia) the fastest improvement in visual acuity was 4.8 lines in 4 months with 6 hours/day patching.

Due to so many limitations of conventional occlusion therapy, it was necessary to look for different types of vision therapy in the management of amblyopia.

Recently a new form of amblyopia treatment called dichoptic therapy in which a reduced contrast in the dominant eye (in form of video games or movie watching) to equate the visibility comparable to the amblyopic eye yielded reduction in the strength of interocular suppression and modest visual acuity improvement of amblyopic eye after just 1 - 5 weeks [13-16]. A Cochrane database review in 2015 on binocular therapies for amblyopia recommended that results from non-controlled cohort studies are encouraging and further research is necessary [17].

In that context, we report the results of a home based as well as office based dichoptic vision therapy in treatment of residual amblyopia.

Materials and Methods

This prospective cohort study included children aged ≥ 6 years or adults with isoametropic (one eye affected more and the inter eye acuity difference of ≥ 2 lines on Baily Lovie type vision charts), anisometropic or strabismic residual amblyopia. We included only those patients who did not respond to 100% compliance to 6 hours/day patching for at least 3 months and full time-full spectacle correction of the refractive error. Patients with deprivational amblyopia or any other ocular comorbidity or neuronal defects were excluded. The patients were randomly assigned to office therapy or home therapy between 1st April 2016, to 31st July 2016.

Office therapy (Group 1)

Twenty minutes session of anti-suppression therapy using monocular fixation in binocular field (MFBF) were given using Sanet Vision Integrator (SVI) (HTS Inc., USA) touch screen system followed by 20 minutes of contour and random dot stereopsis exercises on 3D screen of the vision therapy system 4 (VTS4) (HTS Inc., USA). The contrast of the dominant eye target was kept at the lowest level which induced fusion in the patient. In patients with large manifest squint and suppression despite of lowest contrast in front of dominant eye, binasal occlusion was utilized to induce fusion to begin MFBF therapy. Following 2-3 sessions, none of the patients needed binasal occlusion. Alternate day sessions were given for 6 weeks and the data was analysed. The patching of 2 hours/day was continued along with the office therapy. Spatial frequency (crowding) of the stimulus was progressively increased on SVI as the visual acuity improved.

Home therapy (Group 2)

5 hours/week of MFBF was given for 6 weeks sans patching using 3D anyglyph goggles and android game called Stereoblocks. The dominant eye settings of the stereoblock game were adjusted to 30% contrast (lowest) and the lazy eye setting was adjusted to 100% contrast essentially leading to fusion response. Data was analysed after 6 weeks of therapy.

Results

In group 1, sixteen eyes of 11 children were included. 5 had bilateral (isoametropic with inter eye acuity difference of ≥ 2 lines) and 6 had unilateral (anisometropic/strabismic/mixed) amblyopia. Mean age was 12.5 years. Mean improvement in bilateral amblyopia (n = 10) was 0.26, $p < 0.01$ (paired t test) and in unilateral amblyopia (n = 5) it was 0.28, $p = 0.05$. Maximum improvement in bilateral amblyopia was 0.48 (5 lines on logMAR chart) and in unilateral was 0.6 (6 lines). 4 patients with age > 18 years experienced mean 2.5 lines improvement.

In group 2, seven eyes of seven patients aged 6 - 15 years were included. Five had strabismic amblyopia and 2 had anisometropic amblyopia. The best corrected vision improved in all with a mean 1.8 lines (range 1 - 3 lines).

Discussion

In this pilot study, MFBF or the dichoptic vision therapy was associated with significant improvement in visual acuity of the eye with residual amblyopia. The improvement was more rapid compared to conventional occlusion and more effective in office based therapy either because of simultaneous part time patching or due to monitored therapy or both.

The principle of the dichoptic therapy/MFBF is that a contrast adjusted stimulus is presented exclusively to each eye (lower contrast/saturation in front of dominant eye) where-in the image of right eye was visible only to that eye and the image of the left eye was visible only to the left eye. The brain was forced to integrate the images into a single perception.

Normally binocular interaction does not occur in amblyopia. Weak, noisy signals from the amblyopic eye can contribute to binocular vision if suppression by the fellow eye is reduced when fellow-eye contrast is reduced (or by any other method of by signal attenuation) [18,19].

Recently work from various investigators have demonstrated that dichoptic treatment by home therapy or office therapy or using dichoptic movies can be useful in children as well as adult amblyopia [13-16].

In the study by Birch EE [20,21] binocular iPad treatment for amblyopia was given. The results of 4 hours/week for 4 weeks of sham games versus iPad dichoptic games were compared. Sham iPad group had no significant improvement as expected. Binocular iPad group had mean visual acuity improvement by > 1 line. They found more improvement with more compliance and more improvement (3 lines more) with associated patching, similar to what we have experienced during this study. With iPad games, best improvement was 4.7 lines in 1 month and the continued treatment did not show further improvement. Also, there was no recurrence after cessation for 3 months. They reported no effect on stereoacuity. The limitation of the treatment was compliance because the tasks are intensive and repetitive and up to 40% of unsupervised patients were noncompliant. The results are very similar to our study.

There are many other studies by various investigators (Table 1), reporting a modest improvement in the visual acuity (1 - 3 lines) and other visual functions using dichoptic action video games or dichoptic movie watching after 4 - 6 weeks of therapy. The improvement is reported in anisometropic as well as strabismic amblyopes and in the younger as well as older children and young adults. Most studies also report sustenance of the benefits till three months after the cessation of the therapy.

Our study demonstrates a comparable improvement in the mean visual acuity (0.18 logMAR). However, when combined with patching and given in the office, dichoptic therapy resulted in significantly better visual outcome (0.28 logMAR). Further studies with larger samples and randomized controls are needed to confirm.

Year of publication	Location (1st Author)	Design	Dichoptic therapy used	Total number of subjects	Results
2015 [22]	USA	Controlled	Action video game	38	Mean VA improvement = 0.14logMAR Stereopsis improved
2015 [22]	China	Controlled	iPod games or video goggles	30	Contrast Sensitivity improved
2015 [24]	USA	Cohort	Action video game	23	Mean VA improvement = 0.14logMAR Suppression reduced Stereopsis induced
2014 [25]	Canada	Cohort	iPod games	14	Mean VA improvement = 0.11logMAR Mean Stereopsis improvement = 0.6log
2016 [26]	Australia	Controlled	iPod games	30	Fine motor skills improved
2016 [27]	USA	Controlled	iPad games	385	Mean VA improvement = 0.1logMAR
2015 [20]	USA	Controlled	iPad games	50	Mean VA improvement = 0.11logMAR
2015 [28]	USA	Cohort	Movie watching	8	Mean VA improvement = 0.2logMAR
2012 [16]	UK	Cohort	Perceptual learning	14	Mean VA improvement = 0.1logMAR
2016 [10]	USA	Controlled	iPad games	28	Mean VA improvement = 0.16logMAR
Current Study	India	Cohort	Android games and Sanet Vision Integrator (HTS Inc. USA)	18	Mean VA improvement = 0.18logMAR

Table 1: *A comparison of outcomes of recently published dichoptic therapies.*

Conclusion

In summary, new dichoptic therapies are promising in the treatment of residual amblyopia. The effectiveness may be more for office therapy or when combined with part time patching. Studies are needed to identify the long-term efficacy of these therapies on monocular vision deficits, binocular vision deficits, oculomotor deficits and visuomotor deficits in patients with amblyopia.

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