

COMPARATIVE EFFECT OF EYE PATCHING USING EYE PAD VERSUS POLARIZING FILM (DICHOPTIC METHOD) FOR AMBLYOPIA TREATMENT

Original Research

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ABSTRACT

Background: Amblyopia is a common visual disorder in children, resulting from abnormal cortical development and characterized by reduced best-corrected visual acuity without an identifiable pathological cause. It is often unilateral and remains a leading cause of monocular vision impairment. Traditional treatment involves occlusion therapy, but recent advancements have introduced binocular approaches, such as dichoptic training, which promote balanced visual input and may enhance treatment compliance and efficacy. This study aims to compare the effectiveness of dichoptic therapy using polarizing films with conventional occlusion therapy in amblyopia treatment.

Objective: To evaluate and compare the efficacy of the dichoptic method using polarizing films and occlusion therapy with an eye patch in improving visual acuity and stereopsis in amblyopic patients.

Methods: This randomized controlled trial was conducted at the Ophthalmology Department of Jinnah Hospital, Lahore. A total of 34 amblyopic patients (16 males, 18 females), aged 3 to 19 years, were enrolled based on inclusion and exclusion criteria. Participants were randomly assigned to either the occlusion therapy group (n=17) or the dichoptic therapy group (n=17). Treatment was administered for two hours daily over six weeks. Baseline and post-treatment assessments included uncorrected visual acuity (UVA), best-corrected visual acuity (BCVA), and stereopsis. Paired t-tests were used for within-group analysis, and statistical significance was set at $p < 0.05$. Data analysis was performed using SPSS Version 27, adhering to the Declaration of Helsinki guidelines.

Results: The mean age was 8.65 ± 4.27 years in the patching group and 10.18 ± 4.36 years in the dichoptic group. Paired t-tests revealed that both treatment methods significantly improved visual acuity, but the dichoptic method demonstrated superior efficacy. In the dichoptic group, UVA improved from 0.04 ± 0.06 to 0.03 ± 0.06 in the right eye and from 0.03 ± 0.06 to 0.05 ± 0.09 in the left eye ($p < 0.05$). The BCVA in the right eye improved from 0.08 ± 0.07 to 0.05 ± 0.09 , while the left eye improved from 0.05 ± 0.09 to 0.03 ± 0.06 ($p < 0.05$). In the patching group, improvements in BCVA of the left eye were significant ($p = 0.034$), but other visual parameters did not reach statistical significance ($p > 0.05$).

Conclusion: Dichoptic therapy using polarizing films significantly improved visual acuity and stereopsis compared to conventional occlusion therapy, demonstrating greater effectiveness in amblyopia management. Given its superior outcomes and potential for better compliance, dichoptic therapy represents a promising alternative to traditional patching methods. Further studies with larger sample sizes and extended follow-up periods are needed to validate these findings.

Keywords: Amblyopia, anisometropia, binocular therapy, dichoptic treatment, occlusion therapy, polarizing film, visual acuity.

INTRODUCTION

Amblyopia is a condition characterized by reduced visual acuity despite appropriate refractive correction and the absence of any underlying biological disease. Its prevalence is estimated to be between 1% and 2%, depending on geographic location (1,2). This visual impairment not only affects visual acuity but also impacts sensory processing, including touch, motion perception, and overall visual information processing, often leading to binocular diplopia, aberrant visual development, and significant functional limitations. Research has demonstrated that amblyopia is associated with reduced cortical oscillations and evoked activity, particularly in cases of anisometric amblyopia (3,4). Compared to other pediatric visual disorders such as retinopathy of prematurity, optic nerve atrophy, and childhood nystagmus, amblyopia is ten times more prevalent and remains a leading cause of vision impairment in children (5). Historically considered a monocular condition, emerging evidence suggests that amblyopia involves both anatomical and functional abnormalities in both eyes. This condition imposes financial, emotional, and psychological burdens on affected children and their families (6). Management of amblyopia is influenced by multiple factors, including the child's age, visual acuity, treatment compliance, and previous therapeutic responses. Conventional treatment strategies include refractive correction with eyeglasses, patching (occlusion therapy), atropine penalization, optical and filtering fogging, and dichoptic training (7). While eyeglasses are the primary intervention due to their ability to provide complete refractive correction, they are effective in only about 30% of cases (8). As a result, occlusion therapy, wherein the sound eye is patched to stimulate the amblyopic eye, remains the most frequently used supplementary treatment (9). However, occlusion therapy is associated with several drawbacks, including occlusion amblyopia, psychological distress, skin irritation, and poor adherence, with compliance rates declining as treatment duration increases (10).

In recent years, novel therapeutic approaches, such as binocular open amblyopia treatment devices and perceptual learning paradigms, have been developed. These methods aim to improve visual function by exposing each eye to distinct visual stimuli or enhancing perceptual performance through experience and practice (11). Historically, amblyopia has been attributed to habitual monocular suppression and a persistent decrease in cortical excitability in the primary visual cortex (V1). However, recent clinical findings suggest that reducing the contrast perceived by the stronger eye allows for the maintenance of binocular visual acuity, supporting the notion that active suppression, rather than structural deficits, underlies binocular dysfunction (12). This has led to the development of dichoptic training, wherein visual stimuli are separately presented to each eye, facilitating interocular input balance and reducing suppression (13). By incorporating tasks such as interactive games, dichoptic therapy aims to enhance both visual acuity and stereoscopic vision (12,14). While traditional occlusion therapy is administered outside the binocular open condition, leading to suppression of the amblyopic eye, binocular treatment strategies provide simultaneous stimulation, potentially yielding superior therapeutic outcomes. Various dichoptic treatment tools have been introduced, including digital devices such as head-mounted displays, smartphones, and tablets (15). However, the high cost and technical requirements of these devices pose accessibility challenges, necessitating the development of a cost-effective, user-friendly alternative (16). In response, a novel dichoptic amblyopia treatment tool utilizing polarizing films has been designed (17). Despite its potential, the therapeutic efficacy of this approach has not yet been directly compared to conventional occlusion therapy. To address this gap, this study aims to compare the effectiveness of occlusion therapy using an eye patch with dichoptic treatment employing polarizing film. Given the critical period for amblyopia treatment, optimizing therapeutic interventions is essential to prevent long-term visual impairment. This research has significant clinical implications, as it may contribute to refining amblyopia treatment protocols and enhancing patient outcomes.

METHODS

This randomized controlled trial was conducted at the Ophthalmology Eye Outpatient Department of Jinnah Hospital, Lahore, over a period of six months following the approval of the study synopsis. Ethical approval was obtained from the institutional review board, and all study procedures adhered to the principles outlined in the Declaration of Helsinki. Written and verbal informed consent was obtained from all participants or their guardians prior to enrollment. Participants included individuals aged 3 to 19 years with newly diagnosed amblyopia, recruited based on predefined inclusion criteria. Eligible participants had unilateral amblyopia due to anisometropia, strabismus, or a combination of both, confirmed through a comprehensive ophthalmologic evaluation. Exclusion criteria included the presence of organic ocular diseases, previous amblyopia treatment, systemic conditions affecting vision, and neurological

disorders (3,4). A total of 34 participants were enrolled and randomly assigned to one of two treatment groups using a simple random sampling technique to ensure equal distribution.

Baseline assessments included a detailed ophthalmic examination, with visual acuity measured using the Snellen chart and converted to logMAR for statistical analysis. Cycloplegic refraction and fundoscopic examination were also performed. Participants in the patching group underwent conventional occlusion therapy, where the dominant eye was covered for four hours per day to encourage visual stimulation in the amblyopic eye. The dichoptic group received treatment using a novel dichoptic method employing polarizing films, which presented distinct visual stimuli to each eye to promote balanced visual input. Both interventions were administered over a period of six weeks, with regular follow-up assessments at weeks 2, 4, and 6, using the same evaluation instruments employed at baseline. Compliance with treatment was monitored through parental reporting and clinician-supervised follow-ups, with adherence rates documented at each visit. Data analysis was performed using SPSS (Version 26). Descriptive statistics, including mean, median, and standard deviation, were calculated for pre- and post-treatment measurements within each group. Paired t-tests were conducted to compare within-group improvements, and independent t-tests were applied to assess differences between the two groups. A p-value of <0.05 was considered statistically significant. A sample size calculation was conducted prior to the study to determine the statistical power needed for detecting significant differences between treatment groups. Strict adherence to ethical guidelines ensured participant confidentiality, data integrity, and compliance with international research standards throughout the study.

RESULTS

The study included 34 participants (16 males, 18 females) who were randomly assigned to either the patching therapy group ($n=17$) or the dichoptic method group ($n=17$). The mean age in the patching therapy group was 8.65 ± 4.27 years (8 males, 9 females), whereas in the dichoptic method group, the mean age was 10.18 ± 4.36 years (8 males, 9 females). Paired t-tests were conducted to assess the significance of visual acuity improvements in both treatment groups. The results indicated that both interventions were effective; however, the dichoptic method yielded more significant improvements in visual acuity compared to the patching therapy. In the dichoptic method group, the mean uncorrected visual acuity (UVA) in the right eye before and after treatment was 0.04 ± 0.06 , and in the left eye, it was 0.03 ± 0.06 . The best corrected visual acuity (BCVA) in the right eye improved from 0.08 ± 0.07 , while the left eye BCVA improved to 0.05 ± 0.09 . The spherical equivalent (SE) in the right eye remained 0.00 ± 0.34 , while in the left eye, it was -0.76 ± 3.16 . Statistical analysis showed that uncorrected and best corrected visual acuity in both eyes were significantly improved ($p \leq 0.05$), whereas spherical equivalent changes were not statistically significant ($p = 1.0$ for the right eye and $p = 0.333$ for the left eye).

In the patching therapy group, the mean UVA in the right eye before and after treatment was 0.02 ± 0.056 , while in the left eye, it was 0.06 ± 0.024 . The BCVA in the right eye improved from 0.03 ± 0.180 , and in the left eye, it improved to 0.05 ± 0.094 . The spherical equivalent (SE) in the right eye changed to -0.08 ± 0.12 , while in the left eye, it was 0.57 ± 2.59 . Statistical analysis revealed that only best corrected visual acuity in the left eye showed significant improvement ($p = 0.034$), while all other visual parameters did not reach statistical significance ($p > 0.05$). A direct comparison of the two groups indicated that the dichoptic method demonstrated superior improvements in both uncorrected and best corrected visual acuity in comparison to the patching therapy. The p-value comparison further supported this observation, as the dichoptic method achieved statistically significant improvements in multiple visual parameters, whereas the patching therapy showed limited significant changes.

Table 1: Paired Sample Analysis of Visual Acuity and Spherical Equivalent Changes Before and After Treatment

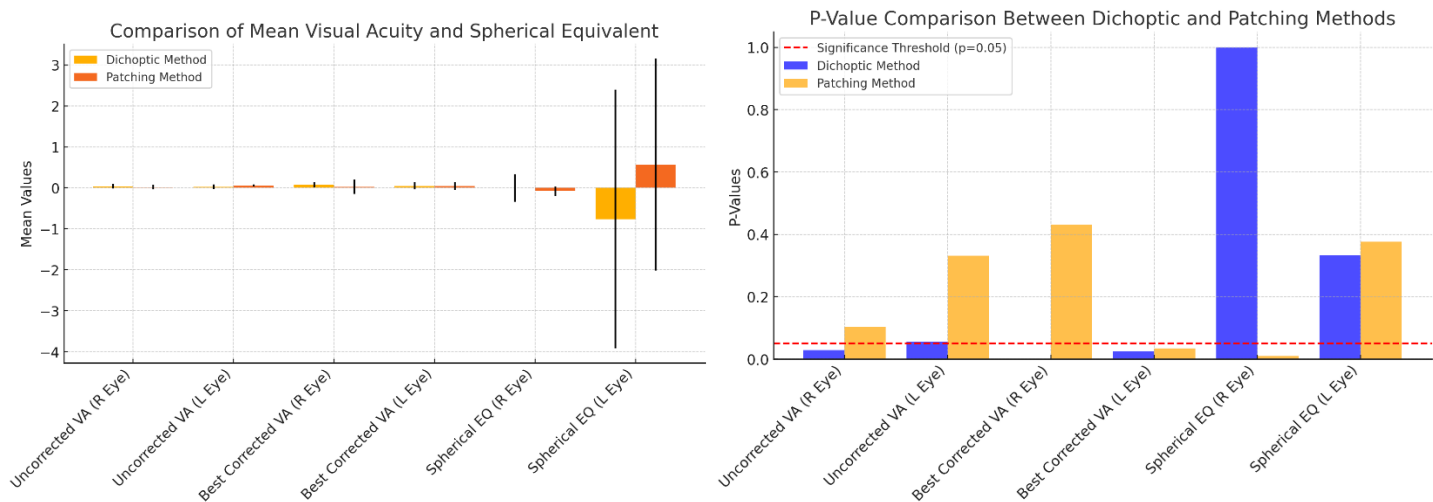
		Paired Differences					p-value
		Mean± Deviation	Std. Std. Mean	Error	95% Confidence Interval of the Difference		
					Lower	Upper	
Pair 1	Uncorrected Visual acuity R eye - AFT. Uncorrected Visual acuity R eye	0.04±0.06	.0147		.0041	.0665	.029
Pair 2	Uncorrected Visual acuity L eye - AFT. Uncorrected Visual acuity L eye	0.03±0.06	.0143		-.0008	.0596	.056
Pair 3	Best corrected Visual acuity before trial R eye - AFT. Best corrected Visual acuity R eye	0.08±0.07	.0176		.0449	.1198	.000
Pair 4	Best corrected Visual acuity before trial L eye - AFT. Best corrected Visual acuity L eye	0.05±0.09	.0212		.0080	.0979	.024
Pair 5	Spherical EQ. R eye - AFT. Spherical EQ. R eye	0.00±0.34	.08303		-.17601	.17601	1.00
Pair 6	Spherical EQ. L eye - AFT. Spherical EQ. L eye	-0.76±3.16	.76561		-2.38772	.85831	0.333

Table 2: Paired Sample Analysis of Visual Acuity and Spherical Equivalent Changes in the Patching Therapy Group

		Paired Differences					p-value
		Mean± Deviation	Std. Std. Mean	Error	95% Confidence Interval of the Difference		
					Lower	Upper	
Pair 1	Uncorrected Visual acuity R eye - AFT. Uncorrected Visual acuity R eye	0.02±.056	0.013		-0.005	0.052	0.104
Pair 2	Uncorrected Visual acuity L eye - AFT. Uncorrected Visual acuity L eye	0.06±.024	0.005		-0.006	0.018	0.332
Pair 3	Best corrected Visual acuity before trial R eye - AFT. Best corrected Visual acuity R eye	0.03±.180	0.044		-0.057	0.127	0.431
Pair 4	Best corrected Visual acuity before trial L eye - AFT. Best corrected Visual acuity L eye	0.05±.094	0.023		0.004	0.101	0.034
Pair 5	Spherical EQ. R eye - AFT. Spherical EQ. R eye	-0.08±0.12	0.029		-0.151	-0.024	0.009
Pair 6	Spherical EQ. L eye - AFT. Best corrected Visual acuity L eye	0.57±2.59	0.627		-.75880	1.899	0.376

Table 3: Demographics

Variable	Patching Group (n=17)	Dichoptic Group (n=17)
Total Participants	-	34
Male	8	8
Female	9	9
Mean Age (Years)	8.65	10.18
Mean Age $\hat{A}\pm$ SD (Patching Group)	8.65 $\hat{A}\pm$ 4.27	-
Mean Age $\hat{A}\pm$ SD (Dichoptic Group)	-	10.18 $\hat{A}\pm$ 4.36



DISCUSSION

The findings of this study indicate that both patching therapy and the dichoptic method employing polarizing films were effective in improving visual acuity in patients with amblyopia. However, the dichoptic method demonstrated greater efficacy, as evidenced by more significant improvements in uncorrected and best-corrected visual acuity compared to patching therapy. These results align with emerging research suggesting that binocular approaches may offer superior visual rehabilitation outcomes by directly addressing interocular suppression and facilitating balanced input from both eyes (3,6). The role of dichoptic training in enhancing visual functions has gained considerable attention in recent years, as it promotes neural plasticity within the visual cortex by presenting independent stimuli to the amblyopic and dominant eyes, thereby strengthening binocular integration (15,16). This study reinforces the growing evidence that dichoptic therapy provides a more effective alternative to traditional patching, which has been associated with compliance challenges and psychological distress (10,18). The study demonstrated statistically significant improvements in uncorrected and best-corrected visual acuity in the dichoptic method group, with all p-values ≤ 0.05 , while spherical equivalent changes remained non-significant. In contrast, patching therapy resulted in less pronounced improvements, with statistical significance observed only in best-corrected visual acuity for the left eye. These findings underscore the limitations of patching therapy, particularly regarding compliance issues and the discomfort associated with prolonged occlusion, which has been reported to reduce adherence over time (19). Although occlusion therapy remains a widely used treatment, its efficacy is limited by poor compliance, leading to suboptimal visual outcomes. The dichoptic method, by maintaining binocular interaction, offers a more engaging and tolerable approach, potentially increasing treatment adherence and effectiveness (20). Despite the promising results of this study, certain limitations must be acknowledged. The sample size was relatively small, which may limit the generalizability of the findings. A larger multicenter study with a more diverse population would strengthen the validity of the results. Additionally, the study primarily focused on visual acuity improvements, while

stereopsis and contrast sensitivity, which are critical indicators of binocular function, were not evaluated. Future studies should incorporate these parameters to provide a more comprehensive assessment of the effectiveness of dichoptic therapy. Furthermore, treatment compliance was monitored through parental reporting, which introduces the possibility of reporting bias. Objective compliance monitoring through electronic tracking devices could provide more accurate adherence data.

Amblyopia treatment outcomes can vary over extended periods, a longer follow-up is necessary to determine the long-term sustainability of visual improvements. Additionally, while the dichoptic method demonstrated superior efficacy, the study did not explore variations in individual response to treatment, which could be influenced by factors such as the severity of amblyopia, age, and underlying etiology. Future research should aim to stratify outcomes based on these variables to optimize personalized treatment strategies. The strengths of this study include its randomized controlled design, which minimizes selection bias and enhances the reliability of the findings. The use of paired t-tests allowed for precise within-group comparisons, strengthening the statistical validity of the conclusions. Moreover, the inclusion of both uncorrected and best-corrected visual acuity measures provided a thorough assessment of treatment effectiveness. The implications of this study extend beyond clinical practice, as the development of cost-effective and accessible dichoptic treatment tools could enhance amblyopia management globally. Traditional dichoptic therapy relies on digital devices such as head-mounted displays and tablet applications, which may be financially and logistically inaccessible to many patients (17,18). The use of polarizing films as a dichoptic treatment tool presents an innovative, low-cost alternative that could improve accessibility while maintaining therapeutic efficacy. Further research is warranted to refine this method, explore its applications in different amblyopia subtypes, and assess its long-term impact on visual function.

CONCLUSION

This study demonstrated that both treatment methods—dichoptic therapy using polarizing films and conventional eye patching—led to improvements in visual function, including visual acuity and stereopsis. However, dichoptic therapy proved to be more effective, yielding significantly better outcomes compared to patching. By promoting binocular integration and reducing interocular suppression, the dichoptic method offers a promising alternative to traditional occlusion therapy, which is often hindered by compliance challenges. These findings highlight the potential for more patient-friendly and effective amblyopia treatment strategies, emphasizing the need for broader implementation of binocular approaches in clinical practice.

Authors Contributions

Authors	Contributions
Muhammad Ali	Manuscript writing, Literature search, Data Collection
Saleh Shah	Supervisor ,Study Design
Muhammad Anwar Awan	Co-supervisor , study design,
Ali Mohsin	Critical review
Ayesha Javed	Data Analysis
Tahira Jabeen	Data Collection, Data Analysis, Data interpretation
Samina Zahoor	Data collection

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