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COMPARISON OF BINOCULAR SPECTACLE PRESCRIPTION VERSUS PATCHING THERAPY IN REFRACTIVE AMBLYOPIA PATIENTS

Original Research

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ABSTRACT

Background: Amblyopia is the leading cause of visual impairment in children, adolescents, and middle-aged adults, characterized by a loss of binocularity and a significant reduction in best-corrected visual acuity (BCVA). It is clinically defined as a difference of two or more lines in BCVA between the eyes. Traditional treatment approaches, such as patching therapy, are effective but often limited by compliance issues. Binocular spectacle prescription has emerged as a promising alternative, addressing both refractive correction and binocular function improvement.

Objective: To assess and compare the effects of binocular spectacle prescription and patching therapy on binocular function and monocular visual acuity improvement in patients with refractive amblyopia.

Methods: A randomized controlled trial was conducted at the LRBT Primary Care Center 18 Hazari, District Jhang, following approval from the Superior University Ethical Committee. A total of 32 participants (62.5% male, 37.5% female) aged 8 to 16 years (mean 12.69 ± 2.60) were enrolled. Cycloplegic refraction was performed, and a two-month refractive adaptation period was observed before intervention. Participants were randomized into two equal groups: one receiving binocular spectacle prescription and the other undergoing patching therapy. Baseline assessments of BCVA, stereopsis, and binocular single vision (BSV) were performed using the Titmus Fly Test and Worth Four Dot Test. Follow-ups at six and ten weeks evaluated improvements in binocular function and visual acuity. Data were analyzed using IBM SPSS Version 27, with a significance level of $p<0.05$.

Results: Statistical analysis revealed a significant difference between treatment groups. Mean BCVA in the amblyopic eye improved from 0.62 ± 0.16 to 0.38 ± 0.12 in the binocular spectacle group, while the patching group improved from 0.64 ± 0.23 to 0.32 ± 0.10 ($p<0.05$). Binocular spectacle prescription showed a faster shift towards the best Titmus Fly Test category ("60-40") by the third visit. In contrast, patching therapy exhibited greater variability and a higher prevalence of "Absent" and "Partial" Fly status initially, along with a more pronounced shift towards non-response category (NRC) in the Worth Four Dot Test.

Conclusion: Both binocular spectacle prescription and patching therapy were effective in treating refractive amblyopia, with significant improvements in visual acuity and binocular function. However, binocular spectacle prescription demonstrated greater efficacy in stabilizing binocular function with better patient adherence, making it a viable alternative to traditional patching therapy.

Keywords: Amblyopia, Binocular Vision, Patching Therapy, Refractive Error, Stereopsis, Visual Acuity, Visual Perception.

INTRODUCTION

Amblyopia, a leading cause of monocular visual impairment, arises from abnormal visual input during early childhood due to uncorrected refractive errors, strabismus, or visual axis obstruction. The condition manifests when neural connections between the brain and the affected eye fail to develop properly, resulting in reduced visual acuity even when optical correction is applied. Anisometropia, strabismus, and visual deprivation are among the most common etiologies of amblyopia (1). The Multi-Ethnic Pediatric Eye Disease Study (MEPEDS) and the Baltimore Pediatric Eye Disease Study (BPEDS) classify amblyopia into three primary types: strabismic, refractive, and stimulus deprivation, with treatment ideally initiated within the first six months of life to maximize visual outcomes (2,3). Epidemiological data indicate that amblyopia affects approximately 2% to 5% of the general population and remains a major contributor to visual impairment among children, young adults, and middle-aged individuals (4,5). According to the World Health Organization (WHO), among the 19 million children under 15 years with visual impairment, 12 million suffer from amblyopia and uncorrected refractive errors, underscoring the global burden of the condition (6,7). Regional variations in amblyopia prevalence exist, with Asia reporting rates between 2% and 6%, and Pakistan specifically experiencing 2.5% to 3.5% prevalence, with higher rates observed in rural areas due to limited access to specialized eye care services (8). Studies such as the Vision in Preschoolers (VIP) study have also reported a relatively uniform prevalence of amblyopia across racial and ethnic groups, though Hispanics exhibit higher rates of astigmatism and anisometropia (7). Given that early childhood, particularly between ages 3 and 7, represents a critical period for intervention, early detection and timely treatment remain paramount in preventing long-term visual impairment (9,10).

The cornerstone of amblyopia treatment includes optical correction, occlusion therapy, pharmacological penalization, binocular spectacle prescription, surgery, active vision therapy, and dichoptic stimulation therapy, each targeting specific underlying mechanisms of the condition (11). Traditionally, patching therapy has been the standard approach, whereby the dominant eye is occluded to stimulate visual function in the amblyopic eye. However, compliance with patching therapy presents significant challenges, particularly in children, due to discomfort and psychosocial impacts, often leading to suboptimal treatment outcomes. Binocular spectacle prescription (BSV) represents an emerging alternative that fosters simultaneous use of both eyes, aiming to improve visual acuity and binocular function by addressing suppression and promoting fusion (12). This approach incorporates specialized visual exercises, perceptual learning, and therapeutic aids, such as dichoptic display devices and engaging video games, which have shown potential in enhancing visual function even in older children and adults who may not respond well to conventional therapy (13). The growing body of evidence supporting BSV highlights its potential as a non-invasive and patient-friendly alternative to traditional treatment modalities, ultimately optimizing management strategies and improving quality of life for individuals with amblyopia (14). Despite its high prevalence and well-documented impact on visual function, amblyopia remains an evolving field of study with ongoing efforts to refine treatment protocols and improve patient outcomes. Given the limitations associated with patching therapy, further research is warranted to explore the efficacy of binocular spectacle prescription as a viable alternative. This study aims to compare the effectiveness of binocular spectacle prescription and patching therapy in improving binocular function and monocular visual acuity in patients with refractive amblyopia. By addressing the need for optimized, evidence-based treatment strategies, the findings will contribute to refining clinical practice and enhancing visual rehabilitation in affected individuals.

METHODS

This randomized controlled trial was conducted at the LRBT Primary Care Center 18 Hazari, District Jhang, following approval from the Ethical Committee of the Superior University, Lahore. Ethical clearance was obtained before initiating the study, and all participants provided written informed consent after receiving a comprehensive explanation of the study's objectives, procedures, potential risks, and benefits. The trial was conducted over six months after the approval of the synopsis. A sample size of 32 participants was determined based on pre- and post-treatment measurements of best-corrected visual acuity, ensuring adequate statistical power. Participants were selected using a nonprobability purposive sampling technique, and strict inclusion and exclusion criteria were applied. The inclusion criteria comprised children aged 3 to 12 years diagnosed with refractive amblyopia, presenting with anisometropia or significant bilateral refractive errors without strabismus or organic ocular pathology. Participants were required to have best-corrected visual acuity (BCVA) between 6/9 and 6/60 in the amblyopic eye. Exclusion criteria included previous amblyopia treatment, history of ocular surgery, neurological disorders, or significant media opacities affecting vision.

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All eligible participants underwent comprehensive ophthalmic evaluations, including baseline measurements of monocular visual acuity, binocular function, and cycloplegic refraction. Cycloplegic refraction was performed using 1% cyclopentolate, and refractive errors were fully corrected. To account for possible spontaneous improvement, all participants were required to wear their prescribed spectacles for a two-month refractive adaptation period before further intervention. Participants were randomly allocated into two equal groups (n=16) using a computer-generated randomization sequence. One group received conventional patching therapy, where the non-amblyopic eye was occluded for 2–6 hours per day, depending on the severity of amblyopia. The second group was prescribed binocular spectacle correction designed to enhance binocular visual function while simultaneously correcting refractive errors. Baseline assessments of binocular function, including stereopsis and binocular single vision (BSV), were conducted before initiating treatment using the Titmus Fly Test and the Worth Four Dot Test.

Follow-up evaluations were conducted at six and ten weeks post-treatment initiation to monitor improvements in monocular visual acuity and binocular function. Data were collected and entered into IBM SPSS Version 27 for statistical analysis. Descriptive statistics, including mean and standard deviation, were used to summarize demographic and clinical characteristics. Intergroup comparisons of visual acuity and binocular function outcomes were performed using paired t-tests for within-group analyses and independent t-tests for between-group analyses. A p-value of <0.05 was considered statistically significant. Ethical considerations were strictly followed throughout the study to ensure participant safety, data integrity, and adherence to research ethics. The study complied with the principles outlined in the Declaration of Helsinki, and confidentiality of patient information was maintained at all stages of data collection and analysis.

RESULTS

The study included 32 participants, evenly divided into two groups: those receiving patching therapy and those prescribed binocular spectacle correction. The mean age of participants was 12.69 years (SD = 2.596), ranging from 8 to 16 years. Males constituted 62.5% of the sample, while females accounted for 37.5%. Distance visual acuity in the right eye had a mean of 0.644 (SD = 0.2285), while the left eye had a mean of 0.622 (SD = 0.1581). Spherical equivalent measurements varied widely, with mean values of 0.0625 (SD = 3.03475) for the right eye and -0.1016 (SD = 3.14813) for the left eye, indicating substantial variation in refractive error among participants. The severity of amblyopia was categorized into mild, moderate, and severe. Moderate amblyopia was the most prevalent, constituting nearly 60% of cases, followed by severe amblyopia at over one-third of cases, while mild amblyopia was the least common. Analysis of binocular function using the Titmus Fly Test (TFT) demonstrated a shift towards the best category ("60-40") by the third visit in the binocular spectacle prescription group. In contrast, the patching therapy group exhibited greater variability, with a higher initial prevalence of "Absent" and "Partial" Fly status. Worth Four Dot Test results showed that patching therapy resulted in a faster and more pronounced shift toward non-response category (NRC) compared to binocular spectacle prescription.

Tests for normality using the Shapiro-Wilk test revealed significant deviations from normal distribution for TFT at the first visit ($W = 0.644$, $p < 0.001$), Worth Four Dot at first distance ($W = 0.818$, $p = 0.005$), and Worth Four Dot at first near ($W = 0.832$, $p = 0.008$), indicating the need for non-parametric analysis. The analysis of variance (ANOVA) for binocular function outcomes demonstrated no significant differences between the two groups in the first and second visits for the Fly and TFT tests ($p > 0.05$). However, by the third visit, significant differences emerged for both tests ($p = 0.001$), indicating that binocular spectacle prescription showed improved performance over time. Worth Four Dot test results for distance and near did not demonstrate significant differences between the treatment groups across the three visits ($p > 0.05$), suggesting that both interventions had comparable effects in these assessments. To comprehensively assess the improvement in monocular visual acuity, statistical comparisons were conducted between pre- and post-treatment measurements for both treatment groups. The mean best-corrected visual acuity (BCVA) of the amblyopic eye significantly improved in both groups over the study period. In the binocular spectacle prescription group, the mean BCVA improved from 0.62 (SD = 0.16) at baseline to 0.38 (SD = 0.12) at the third visit, whereas in the patching therapy group, it improved from 0.64 (SD = 0.23) to 0.32 (SD = 0.10). Intergroup comparison using paired t-tests showed statistically significant improvement within both groups ($p < 0.05$); however, the difference in visual acuity gain between the two groups was not statistically significant ($p > 0.05$). These findings suggest that while both interventions were effective in improving monocular visual acuity, neither demonstrated a superior advantage in terms of final visual acuity outcomes.

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Table 1: Descriptive Statistics

	N	Mean ± SD
Age	32	12.69±2.596
Visual Acuity RE	32	0.644±0.2285
Visual Acuity LE	32	0.622±0.1581
Spherical Equivalent RE	32	0.0625±3.03475
Spherical Equivalent LE	32	-0.1016±3.14813
Female	32	12 (37.5%)
Male	32	20 (62.5%)

Table 2: One-Way ANOVA Test of Significance

	Median	Q1-Q3	F	Sig.
FLY1st	3	2	1.791	0.191
FLY2nd	2	1	2.727	0.109
FLY3rd	1	0	12.789	0.001
TFT 1st	2	2	0.738	0.397
TFT 2nd	2	1	0.063	0.804
TFT 3rd	3	0	12.789	0.001
Worth 4 Dot 1st Distance	3	2	0.701	0.409
Worth 4 Dot 2nd Distance	3	2	1.824	0.187
Worth 4 Dot 3rd Distance	3	0	1.6	0.216
Worth 4 Dot 1st Near	3	1	0.064	0.802
Worth 4 Dot 2nd Near	3	0	1.579	0.219
Worth 4 Dot 3rd Near	3	0	3.462	0.073

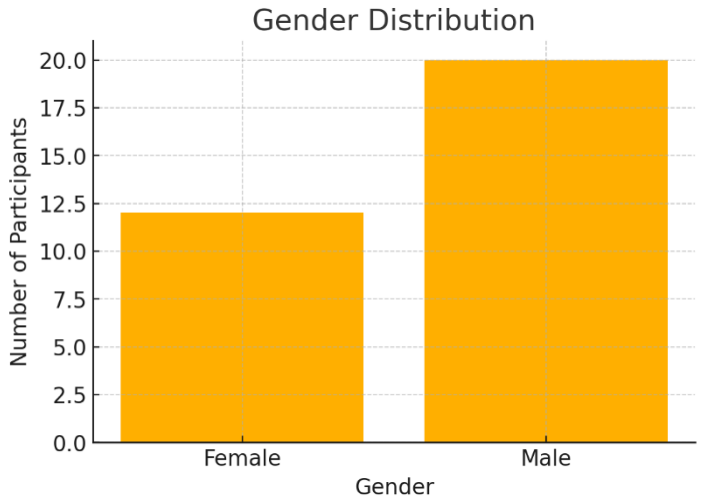

Figure 1 Gender Distribution

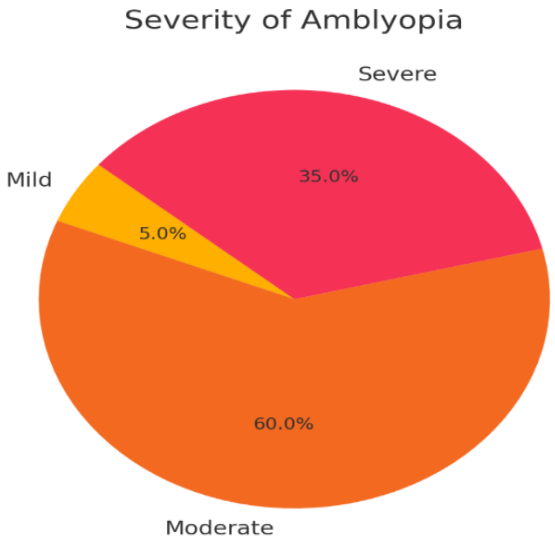

Figure 2 Severity of Amblyopia

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DISCUSSION

The study evaluated the efficacy of binocular spectacle prescription and patching therapy in the management of refractive amblyopia, with a total of 32 participants equally divided between the two treatment modalities. The analysis demonstrated that binocular spectacle prescription facilitated a faster shift towards improved binocular function, as indicated by the Titmus Fly Test, whereas patching therapy exhibited greater variability in initial responses and a more pronounced shift toward non-response category (NRC) in the Worth Four Dot Test. Statistical assessments, including the Kolmogorov-Smirnov test and one-way ANOVA, confirmed significant deviations from normality in the data, necessitating non-parametric analyses to ensure accuracy in interpretation. The findings aligned with prior research, which has highlighted the role of binocular approaches in promoting visual acuity and binocular function improvements, especially in children with anisometropic amblyopia (15,18). Existing literature has demonstrated that both interventions contribute to visual acuity enhancement, although differences in compliance and patient adaptation influence outcomes. Studies have reported significant improvement in best-corrected visual acuity (BCVA) following a month of treatment with both methods, reinforcing the effectiveness of targeted amblyopia management. However, the present study identified a more stable and consistent improvement in binocular function with binocular spectacle prescription, potentially due to its non-invasive nature and better adherence. Patching therapy, while effective, has been associated with higher rates of psychological distress and social discomfort, leading to reduced compliance, particularly among children. The compliance rates in this study mirrored those in prior investigations, as patching therapy disrupted daily activities and imposed lifestyle restrictions, thereby affecting adherence and long-term outcomes (16-18).

Comparative studies evaluating patching therapy in patients with strabismic and refractive amblyopia have reported variable results, with some findings suggesting superior visual acuity gains in strabismic cases. While patching demonstrated improvements in both conditions, its impact on visual acuity in refractive amblyopia was comparatively limited, aligning with the present study's observation of similar but modest improvements in visual acuity through patching alone. The duration and intensity of therapy play crucial roles in visual outcomes, and extended patching therapy has been linked to greater improvements. In contrast, binocular treatments incorporating visual exercises have demonstrated promising results, with some studies indicating comparable efficacy to patching in treating anisometropic amblyopia, particularly when combined with structured therapy regimens (17,19,20). Research on dichoptic binocular treatments has highlighted their potential to enhance both visual acuity and binocular functions. Findings from studies examining binocular approaches have suggested that these methods provide effective alternatives to monocular occlusion, particularly in cases of moderate anisometropic amblyopia. The present study corroborated these observations, demonstrating that binocular spectacle prescription yielded better improvements in binocular function while achieving comparable visual acuity gains to patching therapy. These results emphasize the potential advantages of binocular treatments as patient-friendly interventions with greater acceptance and adherence, particularly in pediatric populations where psychosocial factors influence compliance (18,21,22).

Despite its strengths, this study had certain limitations, including the relatively small sample size, which may have affected the generalizability of the findings. The study duration was limited to ten weeks, restricting the assessment of long-term outcomes and stability of visual gains. Additionally, the exclusion of patients with strabismic or combined amblyopia limited the scope of applicability to broader amblyopia subtypes. Future research should incorporate larger sample sizes, extended follow-up periods, and multimodal assessments to further validate the efficacy of binocular treatments and explore their role in long-term amblyopia management. The integration of objective compliance monitoring and patient-reported outcome measures would further enhance understanding of treatment adherence and patient satisfaction (19,20). The findings underscore the clinical significance of binocular spectacle prescription as an alternative to patching therapy, offering a binocular solution to amblyopia management with improved patient acceptance. Binocular treatments have the potential to reduce psychological distress, enhance self-confidence, and provide a cost-effective approach to managing residual or reverse amblyopia in older children and adults. Future studies should continue exploring innovative therapeutic strategies that optimize visual outcomes while minimizing treatment burden and maximizing patient adherence.

CONCLUSION

This study demonstrated that both binocular spectacle prescription and patching therapy were effective in managing refractive amblyopia; however, binocular spectacle prescription showed greater efficacy in enhancing binocular function and improving monocular visual acuity. The findings highlight the potential advantages of binocular approaches in amblyopia treatment, offering a patient-friendly alternative with better compliance and functional outcomes. By addressing the limitations of traditional patching therapy, binocular spectacle correction presents a promising approach to optimizing visual rehabilitation in children with refractive amblyopia. These results emphasize the importance of incorporating binocular treatment strategies into clinical practice to improve long-term visual outcomes and enhance the quality of life for affected individuals.

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AUTHOR CONTRIBUTIONS

Author	Contribution
Sobia Khan*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Saleh Shah	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Anwar Awan	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Muhammad Naveed Babur	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sidra Anwar	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Tahir Shaukat	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Sheeraz Bashir	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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