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Depth of Suppression in Adults with Amblyopia Post Anti-Suppression Therapy

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Abstract

Amblyopia is a developmental visual disorder resulting from abnormal visual experience during early life and is characterized by reduced best-corrected visual acuity in one or, less commonly, both eyes in the absence of identifiable structural abnormalities. This study evaluated changes in depth of suppression in adults with amblyopia following a structured program of office-based anti-suppression therapy. Participants underwent ten in-office sessions, and high-contrast crowded visual acuity along with depth of suppression were measured using Bagolini striated glasses with neutral density filters before and after therapy. Results demonstrated a significant reduction in depth of suppression accompanied by improved visual acuity, indicating that anti-suppression therapy effectively enhances binocular visual function in adult amblyopes.

Keywords: Amblyopia; Suppression; Vision therapy

Introduction

Amblyopia, commonly known as "lazy eye," is a neurological condition that occurs during early development due to abnormal visual experiences. [1] The Amblyopia Treatment Study defines amblyopia as a developmental disorder affecting spatial vision and leading to reduced visual acuity (VA) in one eye, or less commonly, in both eyes. This condition is not associated with any apparent structural abnormalities or ocular diseases. [2] In clinical terms, amblyopia is diagnosed when the Best Corrected Visual Acuity (BCVA) is below 6/9 (0.2 LogMAR or equivalent) in monocular Snellen optotypes, or when there is a difference of two or more lines in BCVA between the eyes using logMAR optotypes.

Visual Deficits in Amblyopia

Besides reduced BCVA, there are a large range of visual function deficits of the amblyopic eye which include abnormal contour interaction, [3] reduced contrast sensitivity, [4] positional uncertainty, [5] spatial distortion, [6] poor accommodation, [7] abnormal eye movements, [8] and suppression. [9] Reduced reading speed [10] and compromised fine-motor skills [11] have also been reported in amblyopes.

Suppression And Amblyopia

Li et al. (2011) explicitly measured suppression in amblyopic individuals using clinical methods including the Worth Four Dot test and quantitative dichoptic motion thresholds. They found a direct correlation between depth of suppression and amblyopia severity, indicating that stronger suppression is

associated with greater interocular acuity differences and worse stereoacuity. [12] Recent binocular imbalance research echoes this, arguing that loss of binocularity and suppression are central to amblyopia and may even precede monocular acuity loss in the condition's development. Quantifying suppression is increasingly recognized as important for treatment targeting. [13]

The Worth Four Dot Test (W4DT) is one of the most widely used clinical tools for identifying the presence of sensory suppression in patients with binocular vision anomalies. It provides a simple and practical method for determining whether suppression is present under specific testing conditions. While the W4DT is effective in detecting the existence of suppression, it primarily yields qualitative information and does not quantify the depth or extent of suppression. To the best of our knowledge, the current literature has largely focused on the presence or absence of suppression in amblyopic patients, with limited attention to characterizing changes in the magnitude or extent of suppression following amblyopia therapy.

The primary aim of this study was to evaluate changes in the depth of suppression in adults diagnosed with amblyopia following office-based anti-suppression therapy. The objectives were as follows:

a. To assess the depth of suppression in the amblyopic eye before and after completion of a structured course of office-based anti-suppression therapy.
b. To evaluate changes in high-contrast crowded visual acuity in adults with amblyopia following anti-suppression therapy.

Methods

The data for this study were retrospectively abstracted from the electronic medical records (EMR) of a tertiary eye care centre over a ten-month period, from January 2025 to October 2025. Subjects included in the study were young adults aged 18–35 years who had a confirmed clinical diagnosis of amblyopia, based on standard diagnostic criteria including reduced best-corrected visual acuity not attributable to any structural ocular pathology. Patients with a history of active ocular disease, prior binocular vision therapy within the last six months, neurological disorders affecting vision, or uncorrected significant refractive error were excluded to minimize confounding factors.

At baseline, each participant underwent a comprehensive binocular vision assessment, which included measurement of high-contrast crowded visual acuity (100%) using standardized logMAR charts under habitual correction. Suppression was evaluated using Bagolini striated glasses, a well-established clinical tool for assessing sensory fusion and interocular suppression under near-natural viewing conditions. To quantify the depth of suppression, neutral density (ND) filters were introduced incrementally in front of the dominant eye until simultaneous perception of images from both eyes was achieved. The minimum ND filter density required to break suppression was recorded as an indicator of depth of suppression.

Following baseline assessment, participants underwent ten sessions of in-office anti-suppression therapy, delivered under supervised clinical conditions. The therapy protocol was designed to reduce interocular suppression and promote binocular interaction through structured dichoptic and anti-suppression activities. Each session was standardized in duration and progression, ensuring consistency across participants.

Upon completion of the therapy sessions, all outcome measures were reassessed using the same testing protocols employed at baseline. Post-therapy measurements included high-contrast crowded visual acuity and depth of suppression using Bagolini striated glasses with neutral density filters. Pre- and post-

therapy data were then compared to evaluate the effectiveness of anti-suppression therapy in improving binocular sensory balance and visual function in adult amblyopes.

IBM® SPSS® Statistics 20.0 was used for data entry and analysis. Paired t-tests were used to demonstrate the primary outcome and a two-sided significance level of 0.05 was considered statistically significant.

Results

A total of 65 subjects were included in the study, with a mean age of 21.7 ± 1.5 years (range: 18–35 years). Of these, 26 subjects (40%) were male and 39 (60%) were female**.** Based on the etiology of amblyopia, 32 subjects (49.2%) had refractive amblyopia**,** 15 (23.1%) had strabismic amblyopia**,** 8 (12.3%) had deprivational amblyopia**,** and 10 (15.4%) had mixed amblyopia**.** At baseline, prior to anti-suppression therapy, the mean high-contrast crowded visual acuity in the amblyopic eye was 0.56 ± 0.15 logMAR**.** The mean depth of suppression**,** measured using Bagolini striated glasses in conjunction with neutral density filters, was 1.30 ± 0.60 log units**.** Following completion of ten sessions of in-office anti-suppression therapy, a significant improvement was observed in both outcome measures. At the final follow-up, the mean high-contrast crowded visual acuity improved to 0.40 ± 0.20 logMAR, while the mean depth of suppression reduced to 0.66 ± 0.50 log units**.** Statistical analysis using a paired sample t-test demonstrated that the improvements in high-contrast crowded visual acuity and depth of suppression were highly statistically significant **(**$p < 0.001$ for both parameters).

Table 1: Pre- and Post-Vision Therapy Changes in High-Contrast Crowded Visual Acuity and Depth of Suppression

	Pre vision therapy	**Post vision therapy**	**p-value**
High contrast visual acuity crowded visual acuity (SD) (logMAR)	0.56 ± 0.15	0.40 ± 0.20	0.001
Depth of Suppression (SD) (logMAR)	1.30 ± 0.60	0.66 ± 0.50	0.0002

Discussion

Visual dysfunction in amblyopia is increasingly understood as a binocular disorder, characterized by abnormal binocular interactions and active suppression of inputs from the amblyopic eye under binocular viewing conditions. [1, 13] This suppression is considered a key neural adaptation that prevents visual confusion and diplopia but, in doing so, contributes to reduced visual acuity, impaired stereopsis, and overall binocular dysfunction. [12]

Recent literature has reported the effectiveness of anti-suppression and binocular therapies in improving both monocular visual acuity and binocular functions, primarily by reducing interocular suppression and promoting binocular fusion. Unlike traditional monocular occlusion therapy, which focuses solely on improving the amblyopic eye, anti-suppression approaches target the underlying binocular imbalance. Improvements in visual acuity observed following such therapies are thought to be mediated by restoration of binocular cooperation rather than isolated monocular gains. [14-16]

Given the central role of suppression in amblyopia, quantifying the extent of suppression is critical for assessing treatment efficacy. Clinical tools such as Bagolini striated glasses combined with neutral density filters provide a practical method for evaluating suppression under near-natural viewing conditions. The results of this investigation showed a significant reduction in the depth of suppression following in-office anti-suppression therapy across all types of amblyopia, including refractive, strabismic, deprivational, and mixed amblyopia. This reduction in suppression was accompanied by an improvement in high-contrast crowded visual acuity, supporting the hypothesis that reducing suppression facilitates functional visual improvement.

Conclusion

Office-based anti-suppression therapy produced a significant reduction in the depth of suppression, accompanied by a clinically meaningful improvement in high-contrast crowded logMAR visual acuity in adults with amblyopia. These findings support the concept that modifying binocular interaction can yield functional visual gains beyond the traditional critical period. Quantitative assessment of suppression may serve as a useful clinical outcome measure for monitoring therapeutic response and guiding binocular treatment strategies in adult amblyopia.

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