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# Pinhole Fitted Spectacle: An Effective Way of Treating Amblyopia in Children aged 05 -15 years

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## ABSTRACT

**Background:** Amblyopia is the most common cause of preventable monocular visual impairment in children. Traditional occlusion therapies, though effective, but also encountered with high failure rate often. This study evaluates the effectiveness of a single pinhole occluder fixed over the top of spectacles lens a non-invasive better alternative for improving visual acuity in children with refractive amblyopia.

**Aim:** To determine the visual outcome in amblyopic children aged 5–15 years after fitting a single pinhole occluder over their corrective spectacles.

**Methods:** A prospective observational study was conducted at ESIC Hospital, New Delhi, involving 30 children aged 5–15 years diagnosed with refractive amblyopia. After one month of optical adaptation with prescribed spectacles, a single pinhole occluder was mounted over the amblyopic eye (or both eyes in bilateral cases). Visual acuity was assessed using the Log MAR chart at baseline and at three subsequent follow-ups. Statistical analysis was performed using SPSS v23.0 with significance set at $p<0.05$.

**Results:** The mean Log MAR visual acuity significantly improved in both eyes. In the right eye, acuity improved from $0.37 \pm 0.30$ at baseline to $0.21 \pm 0.18$ at the third follow-up ($p=0.0462$). The left eye showed improvement from $0.45 \pm 0.33$ to $0.26 \pm 0.17$ ($p=0.0110$). Both isometropic and anisometropic amblyopia responded well, with no statistically significant association between the type of amblyopia and the refractive error subtype ($p=0.3046$).

**Conclusion:** Pinhole-fitted spectacles are a simple, economical, effective, and child-friendly adjunct for the treatment of refractive amblyopia. They offer a promising alternative to traditional occlusion therapy, particularly in cases where compliance is a challenge.

***Keywords:*** *Amblyopia, Pinhole Occluder, Refractive Amblyopia, Paediatric Ophthalmology, Visual Acuity, Compliance.*

## 1. INTRODUCTION

Amblyopia, often called "lazy eye," is the most common cause of preventable monocular visual impairment in children, with a prevalence ranging from 1% to 5% worldwide. [1] It is a developmental visual disorder characterized by decreased best-corrected visual acuity in one or both eyes that cannot be attributed solely to structural abnormalities of the eye or visual pathways. Early diagnosis and treatment during the critical period of visual development are essential for optimal visual recovery. [2]

The traditional management of amblyopia involves correcting refractive errors followed by occlusion therapy, either by patching the dominant eye or using pharmacologic penalization. [3] Despite being effective, these methods often encounter compliance issues due to discomfort, social stigma, or psychosocial factors associated with patching. [4]

The pinhole occluder is a simple optical device that improves visual acuity temporarily by allowing light rays to pass only through the central part of the pupil, thereby minimizing the effects of refractive errors and unmasking potential visual improvement. The integration of a single pinhole occluder with corrective spectacles may serve as a novel, non-invasive adjunct to amblyopia management by enhancing retinal image clarity and encouraging the use of the amblyopic eye.[5, 6]

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However, the use of pinhole occluders as a therapeutic aid rather than a diagnostic tool remains under-investigated. This study aims to determine the visual outcome in amblyopic children after fitting a single pinhole occluder over their spectacles.

This research has been formally registered with the Clinical Trials Registry of India (CTRI/2022/05/055778) and protected under the Indian Designs Act (Design No. 418379-001, registered on 29/05/2024). A patent application (No. 202411048045) has also been filed to safeguard this innovation.

## 2. MATERIALS AND METHODS

This prospective, observational study was conducted at ESIC Hospital, Sector 15, Rohini, New Delhi. Approval for the study protocol was obtained from the Institutional Ethics Committee prior to commencement.

A total of 30 children aged 5 to 15 years with refractive amblyopia, BCVA ≤0.3 LogMAR (≤6/12), and normal central fixation were included after obtaining parental consent. Whereas patients with strabismus, visual deprivation (e.g., corneal opacities, cataract, retinal disease), or systemic illness-related vision issues were excluded from the study.

Subjects underwent a comprehensive ophthalmic evaluation, which included direct and indirect ophthalmoscopy, anterior segment examination, and orthoptic assessment by an ophthalmologist. Cycloplegic refraction was performed, and participants were called back for a post-mydriatic test (PMT) to determine best-corrected visual acuity (BCVA). Children with BCVA worse than Log MAR 0.20 or 6/9 were further assessed, and only those whose visual acuity did not improve with pinhole testing were diagnosed with refractive amblyopia and included in the study.

Following optical correction, all subjects underwent 6 weeks of optical adaptation using their prescribed spectacles. Their visual acuity was then reassessed using both Snellen and Log MAR charts. A key step in the intervention was accurately marking the interpupillary distance (IPD) on the spectacle frame to determine the correct central eye position for pinhole placement.

In cases of unilateral refractive amblyopia, the sound eye was occluded using an adhesive patch or rubber occluder, and a single pinhole plastic occluder was mounted over the amblyopic eye, precisely aligned with the IPD marking (figure 1). For children with bilateral amblyopia, pinhole occluders were fixed bilaterally. Participants were observed for 30 minutes after fitting to ensure comfort and to allow for any necessary adjustments to the device. A follow-up visit was scheduled after 15 days to assess compliance and verify whether the child was following the prescribed use of the pinhole occluder.

**Figure 1. A Single pinhole fitted spectacle**

Adherence to the wearing schedule was strongly emphasized throughout the study, as inconsistent use could result in reverse amblyopia or reduced treatment efficacy. The importance of compliance was reinforced with both the child and caregiver during each visit.

### Statistical analysis

Data was assessed using SPSS v 23.0 software. Continuous data was expressed in mean and SD whereas, categorical data presented in frequency and percentage. Categorical variables were compared using Cho-square test. One-way ANOVA followed by post Hoc test was used to compare VA at different time intervals. $P<0.05$ was considered as statistically significant.

## 3. RESULTS

The mean age of the study subjects was 9.33±3.04 years. Among them, 20 children (66.67%) were in the 5–10 years age group, while 10 children (33.33%) were in the 11–15 years age group. Males constituted the majority of the study population (18, 60%), whereas females comprised 12 (40%) (Table 1).

**Table 1. Distribution of age and sex**

| Variables | Subcategories | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Age (n=30) | 5-10 years | 20 | 66.67 |
| | 11-15 years | 10 | 33.33 |
| Sex (n=30) | Female | 12 | 40 |
| | Male | 18 | 60 |

Among the study subjects, n=14 (46.67%) children had vision problem without ocular symptoms while n=16 (53.33%) children had ocular symptoms. The most common ocular symptoms including headache, watering, pain in eye, irritation, redness, and itching.

In this study, 50% (n=15) of children had isometropic amblyopia and 50% (n=15) had anisometropic amblyopia. Distribution to type of refractive error based on type of amblyopia revealed that compound hypermetropic astigmatism (CHA) was predominantly seen in cases with anisometropic amblyopia (53.33) whereas compound myopic astigmatism (CMA) was more common in isometropic amblyopia patients (60%). However, there was no significant association between type of amblyopia and type of refractive error (P=0.3046) (Table 2).

**Table 2. Distribution of types of refractive error according to types of amblyopia**

| Type of RE | Type of amblyopia n, (%) | | P-value |
|---|---|---|---|
| | Anisometropic | Isometropic | |
| CMA | 5 (33.33) | 9 (60) | 0.3046 |
| CHA | 8 (53.33) | 5 (33.33) | |
| MCA | 0 (0) | 1 (6.67) | |
| SMA | 1 (6.67) | 0 (0) | |
| SH | 1 (6.67) | 0 (0) | |
| Total | 15 (100) | 15 (100) | |

CMA- Compound myopic astigmatism, CHA- Compound hypermetropic astigmatism, MCA- Mixed compound astigmatism, SMA- Simple myopic astigmatism, SH- Simple hypermetropia.

In children with amblyopia treated using pinhole-fitted spectacles, the mean LogMAR visual acuity in right eye improved progressively from 0.37 ± 0.30 before intervention to 0.26 ± 0.18 at the first follow-up, 0.24 ± 0.21 at the second follow-up, and 0.21 ± 0.18 at the third follow-up. This improvement was statistically significant, with a P-value of 0.0462. Similarly, the left eye showed a significant improvement in mean LogMAR visual acuity from 0.45 ± 0.33 before intervention to 0.31 ± 0.21, 0.28 ± 0.18, and 0.26 ± 0.17 at the first, second, and third follow-ups respectively (P=0.0110) (Table 3).

**Table 3. Comparison of visual acuity at different time intervals**

| Side of the eye | LogMAR (mean±SD) | | | | P-value |
|---|---|---|---|---|---|
| | Before intervention | At first follow-up | At second follow-up | At third follow-up | |
| Right | 0.37±0.30 | 0.26±0.18 | 0.24±0.21 | 0.21±0.18 | 0.0462 |
| Left | 0.45±0.33 | 0.31±0.21 | 0.28±0.18 | 0.26±0.17 | 0.0110 |

## 4. DISCUSSION

Amblyopia remains one of the leading causes of preventable monocular visual impairment in children. Traditional management strategies such as occlusion therapy, although effective, often suffer from poor compliance due to cosmetic concerns and social stigma associated with patching. This study investigates a novel, non-invasive approach—pinhole-fitted spectacles—as an adjunct in managing refractive amblyopia, aiming to improve compliance and visual outcomes in children

aged 5–15 years.

In our study population of 30 children, the mean age was 9.33 years, with the majority (66.67%) belonging to the 5–10-year age group. This age distribution aligns well with the critical period of visual development during which amblyopia treatment is most effective. [7] The gender distribution showed a slight male preponderance, which may reflect the general trend of higher health-seeking behaviour among male children in certain communities, although amblyopia itself is not gender-biased.

The visual improvement observed with pinhole-fitted spectacles was statistically significant in both eyes over time. The right eye showed improvement in mean Log MAR visual acuity from 0.37 to 0.21, while the left eye improved from 0.45 to 0.26, both with p-values $< 0.05$. These findings suggest that consistent use of pinhole occluder can facilitate measurable enhancement in visual acuity, potentially by promoting focused retinal image formation and stimulating use of the amblyopic eye.

Our results also underscore the value of pinhole devices not merely as diagnostic aids, but as therapeutic adjuncts. While previous literature has primarily focused on the pinhole test for unmasking latent vision potential, its integration into spectacles for regular use is a relatively unexplored avenue. This study supports the feasibility and effectiveness of such an approach, especially in children who demonstrate limited tolerance to traditional occlusion methods.

Interestingly, both isometropic and anisometropic amblyopia responded favorably to the intervention, though compound hypermetropic astigmatism was more common in the anisometropic group, and compound myopic astigmatism predominated among isometropic cases. Despite this variation, no significant association was found between the type of amblyopia and refractive error subtype ($P = 0.3046$), indicating that the pinhole approach may be broadly effective regardless of refractive profile.

One of the critical aspects of this approach was the meticulous alignment of the pinhole with the child's interpupillary distance to ensure optimal optical clarity. Furthermore, regular follow-up and reinforcement of compliance played a vital role in sustaining treatment efficacy, as poor adherence could potentially lead to reverse amblyopia or therapeutic failure.

The main strengths of this study include its prospective design, structured follow-up, and the practical applicability of the intervention. However, certain limitations must be acknowledged. The sample size was relatively small, and the follow-up period was short. Long-term studies involving larger cohorts are needed to determine the durability of visual improvement and assess whether pinhole spectacles can serve as a standalone therapy or adjunct to conventional occlusion methods.

## 5. CONCLUSION

Pinhole-fitted spectacles present a promising, cost-effective, and child-friendly alternative for managing refractive amblyopia. By reducing the psychosocial barriers associated with traditional occlusion therapy and offering measurable improvements in visual acuity, this method may enhance treatment adherence and visual outcomes in paediatric patients. Further research with extended follow-up and comparative studies against standard occlusion therapy is warranted to establish its role in amblyopia management protocols.

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