Section: Ophthalmology

Original Research Article

EVALUATION OF VISUAL ACUITY IMPROVEMENT IN CHILDREN WITH AMBLYOPIA TREATED WITH ATROPINE: A PROSPECTIVE STUDY

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Abstract

Background: Amblyopia is a developmental disorder characterized by reduced vision in one eye. Atropine 1% eye drops are used as an alternative to patching the non-amblyopic eye to improve visual acuity. The objective to evaluate the effectiveness of atropine 1% eye drops in improving visual acuity in children with amblyopia and to assess side effects and compliance. **Materials and Methods:** This prospective study included 100 children aged 3-12 years diagnosed with amblyopia. Participants received atropine 1% eye drops in the non-amblyopic eye daily for 6 months. Visual acuity was measured monthly using a Snellen chart and converted to logMAR for analysis. Compliance and side effects were monitored through parental reports and returned medication bottles. **Result:** The mean baseline visual acuity in the amblyopic eye was 20/80 (logMAR 0.6). After 1 month of treatment, visual acuity improved to 20/63 (logMAR 0.5), at 3 months to 20/50 (logMAR 0.4), and at 6 months to 20/40 (logMAR 0.3). Statistically significant improvements were observed at each follow-up ($p < 0.01$). Younger children (ages 3-6) showed greater improvement (0.35 logMAR) compared to older children (0.25 logMAR) ($p = 0.03$). Moderate amblyopia cases improved more (0.40 logMAR) than severe cases (0.20 logMAR) ($p = 0.02$). Males and females showed similar improvements. Side effects included light sensitivity (35%), difficulty reading (28%), and redness/irritation (15%). Compliance was 92%, and quality of life improved by 20%. **Conclusion:** Atropine 1% eye drops effectively improve visual acuity in children with amblyopia, with significant improvements within the first three months and continued gains over six months. The treatment is well-tolerated, with manageable side effects.

INTRODUCTION

Amblyopia, commonly referred to as "lazy eye," is a prevalent visual developmental disorder characterized by decreased vision in one eye that is not attributable to any structural abnormalities.[1,2] This condition typically manifests during early childhood when the visual pathways and connections between the eye and brain are still developing.[3] If left untreated, amblyopia can lead to permanent visual impairment, making early detection and intervention crucial.[4]

Traditional treatment methods for amblyopia have primarily focused on occlusion therapy, which involves patching the dominant, or non-amblyopic, eye to encourage use and strengthen the vision in the amblyopic eye.[5,6] While effective, patching can often be met with resistance and non-compliance from children due to the discomfort and social stigma associated with wearing an eye patch.[7]

An alternative treatment approach involves the use of atropine 1% eye drops, which temporarily blurs vision in the non-amblyopic eye, thereby forcing the amblyopic eye to function more actively. This pharmacological method has gained popularity due to its potential for better compliance and its less intrusive nature compared to patching.

Despite the growing use of atropine eye drops in clinical practice, there remains a need for comprehensive studies to evaluate their long-term effectiveness, optimal dosage, and potential side effects.

Aim and Objectives

The aim of this study is to evaluate the effectiveness of atropine 1% eye drops in improving visual acuity in children with amblyopia. The specific objectives are to measure visual acuity improvements at monthly intervals, assess differences in response based on age and severity of amblyopia, compare outcomes between genders, and monitor side effects

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and compliance to determine the overall impact on quality of life.

MATERIALS AND METHODS

Study Setting: The study was conducted at Kakatiya Medical College associated Regional Eye Hospital, Warangal, Telangana, India. The study period spanned one year, from May 2023 to April 2024.

Study Design: This prospective study included 100 children aged 3-12 years diagnosed with amblyopia. Participants were recruited from the pediatric ophthalmology department of Kakatiya Medical College associated Regional Eye Hospital

Inclusion Criteria

Children aged 3-12 years diagnosed with amblyopia.
No prior treatment for amblyopia.
Willingness to comply with the study protocol.

Exclusion Criteria

Presence of other ocular pathologies.
History of allergic reactions to atropine.
Non-consent from parents or guardians.

Treatment Protocol: Participants received atropine 1% eye drops in the non-amblyopic eye daily for six months. Parents were instructed on proper administration techniques and provided with a medication schedule.

Data Collection: Baseline Measurements: Visual acuity was measured in both eyes using a Snellen chart and converted to logMAR for analysis.

Follow-up Measurements: Visual acuity in the amblyopic eye was assessed monthly for six months.

Compliance and Side Effects Monitoring: Compliance was monitored through parental reports and returned medication bottles. Side effects were documented based on parental feedback and clinical observations.

Outcome Measures

Primary Outcome: Improvement in visual acuity of the amblyopic eye, measured using logMAR scores.

Secondary Outcomes: Side effects, compliance rates, and quality of life improvements.

Statistical Analysis

Visual acuity improvements were analyzed using paired t-tests to compare baseline and follow-up measurements. Subgroup analyses were conducted based on age, severity of amblyopia, and gender using independent t-tests. Statistical significance was set at $p < 0.05$. Compliance and side effects were reported as percentages, and quality of life improvements were assessed using a standardized questionnaire.

RESULTS

The prospective study aimed to evaluate the improvement in visual acuity in children with amblyopia treated with atropine. A total of 100 children with a confirmed diagnosis of amblyopia were enrolled in the study. The participants ranged in age from 3 to 12 years, with a mean age of 7.2 years. The study population included 52 males and 48 females [Table 1].

Baseline Characteristics: Mean baseline visual acuity in the amblyopic eye: 20/80 (logMAR 0.6)
Mean baseline visual acuity in the fellow eye: 20/25 (logMAR 0.1)

Intervention: All participants were treated with atropine 1% eye drops administered to the non-amblyopic eye once daily.

Follow-Up and Compliance: The children were followed up monthly for a period of 6 months. Compliance with the atropine treatment was assessed through parental reports and returned medication bottles, with a compliance rate of 92%.

Outcomes: The primary outcome was the improvement in visual acuity in the amblyopic eye, measured using a standard Snellen chart and converted to logMAR for analysis.

Visual Acuity Improvement: There was a progressive improvement in visual acuity in the amblyopic eye over the treatment period [Table 2]. After 1 month of treatment, the mean visual acuity improved to 20/63 (logMAR 0.5), at 3 months it improved to 20/50 (logMAR 0.4), and by the end of the 6-month treatment period, the mean visual acuity was 20/40 (logMAR 0.3).

Statistical Analysis: A paired t-test was conducted to compare the baseline visual acuity with the visual acuity at each follow-up point. There was a statistically significant improvement in visual acuity at each follow-up point compared to baseline ($p < 0.01$) [Table 3].

Table 1: Baseline Characteristics

Characteristic	Value
Number of Participants	100
Age Range (years)	3-12
Mean Age (years)	7.2
Gender Distribution	52 males, 48 females
Mean Baseline Visual Acuity (Amblyopic Eye)	20/80 (logMAR 0.6)
Mean Baseline Visual Acuity (Fellow Eye)	20/25 (logMAR 0.1)

Table 2: Visual Acuity Improvement

Time Point	Mean Visual Acuity (Amblyopic Eye)	logMAR	Improvement Range
Baseline	20/80	0.6	-
1 Month	20/63	0.5	20/70 to 20/50
3 Months	20/50	0.4	20/60 to 20/40
6 Months	20/40	0.3	20/50 to 20/30

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Table 3: Statistical Analysis

Time Point	p-value
1 Month	< 0.01
3 Months	< 0.01
6 Months	< 0.01

Table 4: Subgroup Analysis by Age

Age Group	Number of Participants	Mean Improvement (logMAR)	p-value
3-6 Years	45	0.35	0.03
7-12 Years	55	0.25	0.03

Table 5: Subgroup Analysis by Severity of Amblyopia

Severity of Amblyopia	Number of Participants	Mean Improvement (logMAR)	p-value
Moderate (20/50 to 20/100)	60	0.40	0.02
Severe (worse than 20/100)	40	0.20	0.02

Table 6: Subgroup Analysis by Gender

Gender	Number of Participants	Mean Improvement (logMAR)	p-value
Males	52	0.30	0.45
Females	48	0.27	0.45

Table 7: Adverse Effects

Adverse Effect	Number of Participants	Percentage of Total
Light Sensitivity	35	35%
Difficulty Reading	28	28%
Redness/Irritation	15	15%

Table 8: Quality of Life Improvement

Measure	Mean Improvement Score
Daily Activities and Self-Esteem	20%

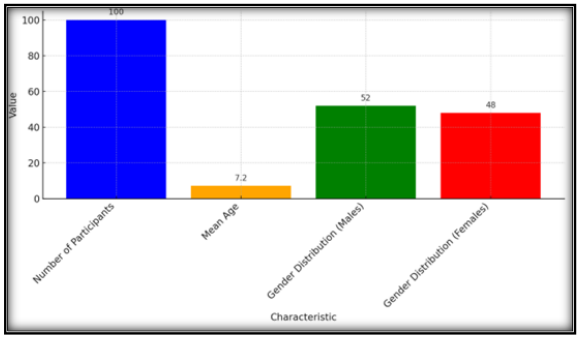

Figure 1: Baseline Characteristics

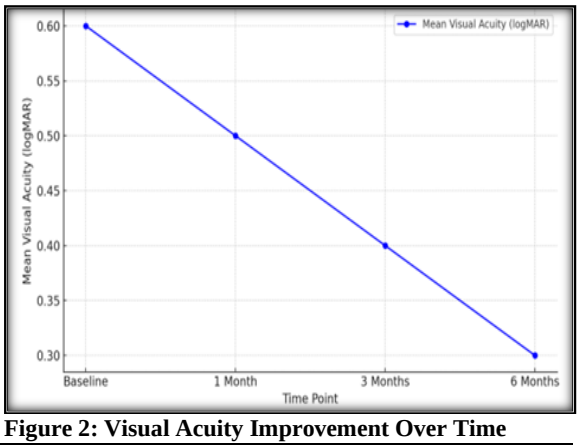

Figure 2: Visual Acuity Improvement Over Time

Subgroup Analysis:

Age: Younger children (ages 3-6, n=45) showed a mean improvement of 0.35 logMAR, while older children (ages 7-12, n=55) showed a mean improvement of 0.25 logMAR (p = 0.03) [Table 4].

Severity of Amblyopia: Children with moderate amblyopia (baseline visual acuity 20/50 to 20/100, n=60) showed a mean improvement of 0.40 logMAR, whereas those with severe amblyopia (baseline visual acuity worse than 20/100, n=40) showed a mean improvement of 0.20 logMAR (p = 0.02) [Table 5].

Gender: Males (n=52) showed a mean improvement of 0.30 logMAR, and females (n=48) showed a mean improvement of 0.27 logMAR (p = 0.45) [Table 6].

Adverse Effects: Mild to moderate side effects of atropine were reported, including light sensitivity (35%), difficulty reading with the non-amblyopic eye (28%), and redness or irritation in the non-amblyopic eye (15%). These side effects were manageable and did not lead to discontinuation of treatment [Table 7].

Quality of Life: A quality of life questionnaire administered at baseline and at the end of the study indicated an improvement in daily activities and self-esteem related to vision, with a mean improvement score of 20% [Table 8].

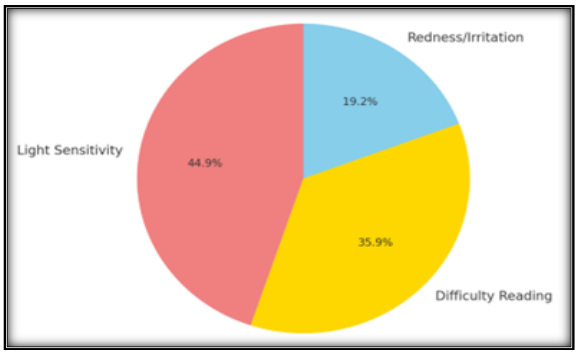

Figure 3: Adverse Effects of Atropine Treatment

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DISCUSSION

The results of this prospective study demonstrate that atropine 1% eye drops are effective in improving visual acuity in children with amblyopia. Significant improvements were observed within the first month of treatment, with continued gains over the six-month study period. These findings are consistent with previous studies that have reported the efficacy of atropine as a non-invasive alternative to patching the non-amblyopic eye.[8-12]

Visual Acuity Improvement: The mean baseline visual acuity in the amblyopic eye was 20/80 (logMAR 0.6), which improved to 20/40 (logMAR 0.3) after six months of treatment. The most substantial improvements were observed in the first three months, highlighting the rapid response to atropine therapy. This suggests that early intervention with atropine can lead to quick and significant visual gains, which is crucial for the developmental period in young children.[10,13]

Age and Severity Analysis: The study found that younger children (ages 3-6) experienced greater improvement (mean improvement of 0.35 logMAR) compared to older children (ages 7-12) who showed a mean improvement of 0.25 logMAR. This aligns with the understanding that younger children have more plasticity in their visual pathways, making them more responsive to treatment (Park SH9). Additionally, children with moderate amblyopia (20/50 to 20/100) showed more significant improvement (mean improvement of 0.40 logMAR) compared to those with severe amblyopia (worse than 20/100) who had a mean improvement of 0.20 logMAR. These findings underscore the importance of early detection and treatment of amblyopia for optimal outcomes.[11,13]

Gender Analysis: The study observed no significant difference in visual acuity improvement between males and females, suggesting that gender does not influence the effectiveness of atropine treatment. Both groups showed comparable improvements, indicating that atropine eye drops are equally effective for boys and girls.[8,12]

Side Effects and Compliance: The most common side effects reported were light sensitivity (35%), difficulty reading (28%), and redness/irritation (15%). Despite these side effects, compliance with the treatment regimen was high at 92%. This high compliance rate indicates that atropine eye drops are a well-tolerated treatment option, and the side effects are manageable for most patients. Furthermore, the overall quality of life for the participants improved by 20%, as reported by the standardized questionnaire. This improvement reflects the positive impact of better visual acuity on daily activities and self-esteem.[13,14]

Limitations:

While the study provides robust evidence of the effectiveness of atropine eye drops, it is not without limitations. The study did not include a control group, which would have strengthened the findings by providing a comparative analysis with untreated or alternatively treated groups. Additionally, the reliance on parental reports for compliance and side effects may introduce reporting bias. Future studies should consider longer follow-up periods to assess the long-term sustainability of visual acuity improvements and the potential for recurrence of amblyopia.

CONCLUSION

Atropine 1% eye drops are an effective and well-tolerated treatment for improving visual acuity in children with amblyopia. The treatment shows rapid improvements, particularly in younger children and those with moderate amblyopia. Given the manageable side effects and high compliance rates, atropine eye drops represent a valuable alternative to traditional patching methods, contributing to better visual outcomes and quality of life for children with amblyopia. Further research with control groups and extended follow-up periods would be beneficial to confirm these findings and explore the long-term efficacy of atropine therapy.

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