

Original Research Article

Effectiveness of low-dose atropine in pediatric myopia management: insights from NIO and H, Dhaka

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ABSTRACT

Background: Myopia, the most common refractive error, is becoming a significant public health challenge due to its rising incidence and associated risks of vision impairment and ocular complications. Low-dose atropine (0.01%) is a promising intervention hypothesized to slow myopia progression by modulating retinal and scleral signaling and reducing axial elongation. Unlike higher concentrations, it has fewer side effects, making it suitable for long-term use in children.

Methods: This prospective comparative study was conducted at the National Institute of Ophthalmology and Hospital in Dhaka, Bangladesh, from June 2023 to July 2024. Fifty-six myopic children aged 6–14 years were divided into two equal groups: one received atropine 0.01% eye drops (Atropine group), while the other received no atropine (Control group). Refractive status (RS) and axial length (AL) were assessed over 12 months using SPSS 26 for data analysis.

Results: Forty-six participants (92 eyes) completed the study. Children aged 6–10 years in the atropine group showed significantly less myopia progression (-0.04 ± 0.09 D vs. -0.38 ± 0.23 D, $p < 0.0001$) and axial length elongation (0.03 ± 0.02 mm vs. 0.21 ± 0.05 mm, $p < 0.0001$). In the 11–14 years subgroup, axial length growth was significantly slower in the atropine group (0.04 ± 0.05 mm vs. 0.20 ± 0.05 mm, $p < 0.0001$), though refractive error differences were not statistically significant. Temporary photophobia was reported in 4.5% of atropine users, with no other adverse effects.

Conclusions: Atropine 0.01% eye drops effectively slow the progression of myopia and axial length growth in children aged 6–14 years.

Keywords: Atropine, Axial length, Myopia, Refractive status, Visual acuity

INTRODUCTION

Myopia or nearsightedness, is a common condition that typically begins in childhood, causing light to focus in front of the retina. It affects over two billion people globally, with 277 million experiencing high myopia (≥ -6.00 D).¹ Pathologic myopia can lead to serious complications, including retinal degeneration and is a major cause of blindness in East Asia.² The progression

of myopia is influenced by environmental factors and genetic predisposition, with significant increases noted in East Asian countries, where prevalence among young adults reaches 85-90%.¹ In Singapore, myopia affects 9-15% of preschoolers and 29% of primary school children, while Taiwan reports a rise from 6% in 6-year-olds to over 70% by age 15. High myopia incidence in Asian people ranges from 6.8% to 21.6%, compared to 2.0% to 2.3% in non-Asian populations.³ Data on myopia

prevalence in Bangladeshi children is lacking, though 22.1% of adults over 30 are affected.⁴ Various strategies have been proposed to slow the progression of myopia: Atropine eye drops at varying concentrations, Pirenzepine 2% gel, Purposeful optical under-correction, increased outdoor activity and sunlight exposure, Bifocal and progressive lenses, Contact lenses such as rigid gas-permeable lenses, peripheral defocus lenses and orthokeratology.^{5,6}

Among these methods, Atropine has been identified as the most efficient pharmacological intervention for slowing myopia progression.⁶ Atropine works locally on the retina, potentially inducing metabolic changes that slow eye growth.⁷ While side effects exist, lower concentrations are preferred in Asia due to better tolerability.⁸ The ATOM study confirmed atropine's efficacy in reducing myopic progression by 75% and a Cochrane review indicated a reduction of 0.80D to 1.0D in myopia progression with treatment, Atropine has been recommended for managing progressive myopia in Taiwan since 2000.^{7,8}

Myopia is a growing concern among children and teenagers worldwide, leading to potential long-term complications such as glaucoma, amblyopia, retinal detachment and myopic maculopathy. Research has shown promising results in using atropine, a non-selective muscarinic antagonist, to slow myopia progression.

However, studies on its efficacy in Bangladeshi children remain limited. This study aims to evaluate the effectiveness of 0.01% atropine eye drops in controlling myopia progression and axial length growth in children aged 6 to 14 years in Bangladesh. If successful, low-dose atropine could become a vital tool in managing childhood myopia, reducing severe complications and providing valuable insights for ophthalmologists and healthcare providers in the region.

The study aims to evaluate the efficacy of 0.01% atropine eye drops in controlling myopia progression and reducing axial elongation in children. Specifically, it seeks to measure and compare changes in refractive error (spherical equivalent) between the atropine-treated and control groups over the study period, quantify and compare changes in axial length in both groups and assess the differences in refractive error and axial length changes between the atropine-treated group and the control group following the final follow-up.

METHODS

Study design

Prospective comparative study conducted at the Department of Pediatric Ophthalmology, National Institute of Ophthalmology and Hospital, Dhaka, Bangladesh, from June 2023 to September 2024.

Study population and sampling

Children aged 6–14 years with myopia attending the Pediatric Ophthalmology Department who met inclusion criteria were included. Purposive sampling technique was applied, yielding a total sample size of 56 children (112 eyes).

Inclusion criteria

The study included children aged 6 to 14 years with myopia ranging from $-1.00D$ to $-5.50D$ spherical equivalent who were Bangladeshi by birth.

Exclusion criteria

Exclusion criteria encompassed children with a history of ocular surgery within the past six months, systemic diseases affecting myopia progression, prior use of myopia control treatments such as orthokeratology or progressive addition lenses, poor compliance with treatment regimens, hypersensitivity to atropine or other anticholinergic drugs, presence of ocular conditions other than myopia, use of ocular medications that could influence myopia progression and monocular vision (having only one functional eye).

Study procedure

Children were divided into two groups.

Group A

Received 0.01% atropine eye drops nightly.

Group B

Control group received no atropine treatment.

All participants were prescribed photochromic glasses for refractive error correction. Follow-ups were conducted at 3, 6 and 12 months, assessing visual acuity, refractive error and axial length growth using standardized ophthalmic examinations and instruments.

Data collection

Detailed ophthalmic and medical history was documented using a structured questionnaire.

Statistical analysis

Data was analyzed using SPSS v26.0, with statistical significance set at $p < 0.05$.

Ethical considerations

Approved by the Ethical Review Committee of NIO&H (Ref: NIO.22.415). Informed consent was obtained from

guardians, with assent from participants, ensuring confidentiality and no financial incentives.

RESULTS

This prospective comparative study evaluated the Efficacy of topical atropine 0.01% eye drop in controlling myopia progression and axial length growth in children with myopia. A total of 56 children with 112 myopic eyes were included in this study and divided into two equal groups (28 in each group) to receive either topical atropine eye drop (0.01%) (Group A) or no atropine (group B) and followed up for one year. However, six children in group A and four children in group B did not complete the follow up schedule. Hence the following result section represented the findings of 22 children (44 eyes) in group A and 24 children (48 eyes) in group B.

Normal distribution of ages among 46 patients, with a single peak around 10 years, a mean age of 10.72 years and a standard deviation of 1.87 years, ranging from approximately 6 to 14 years without significant outliers.

This figure shows that the majority of the respondents were female, accounting for 54.35% (25 respondents), while males comprised 45.65% (21 respondents).

The comparison of age and sex among the groups showed that, in the atropine group (n=22), 54.5% were aged 6-10 years and 45.5% were aged 11-14 years, with a mean age of 10.77 ± 1.92 years. In the control group (n=24), 50.0% were aged 6-10 years and 50.0% were aged 11-14 years, with a mean age of 10.67 ± 1.85 years.

There was no significant difference in age between the groups ($P=0.758$ for age range and $P=0.850$ for mean age). Regarding sex, 45.5% of the atropine group and 45.8% of the control group was male, while 54.5% of the atropine group and 54.2% of the control group was female, with no significant difference between the groups ($P=0.979$).

Table 2 compared the refractive status (spherical equivalent) between the atropine and control groups among children aged 6–10 years across different follow-ups. At baseline and follow-ups at 4, 6 and 12 months, no significant differences were observed between the groups for both eyes. However, by the last follow-up, changes in refractive status showed a statistically significant difference, with the control group experiencing greater progression in both eyes ($p<0.0001$).

Table 3 summarizes the comparison of refractive status (spherical equivalent) between the atropine and control groups among children aged 11–14 years across various follow-ups. At baseline, no significant differences were observed in the refractive status of the right or left eye between groups. Over follow-ups at 3, 6 and 12 months, the refractive status remained statistically similar between

the groups for both eyes. By the final follow-up, changes in refractive status were also not significantly different between the atropine and control groups. Statistical analysis using unpaired t-tests confirmed all differences as non-significant.

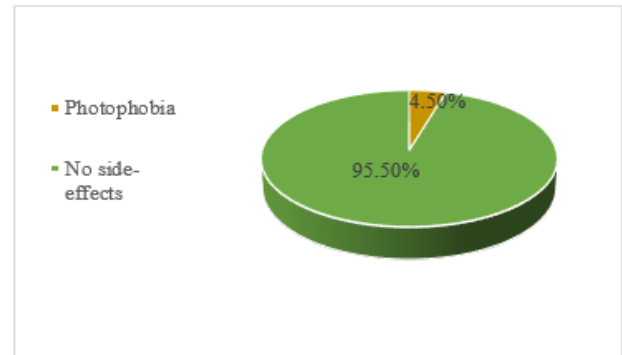


Figure 1: Sex of the patients (n=46).

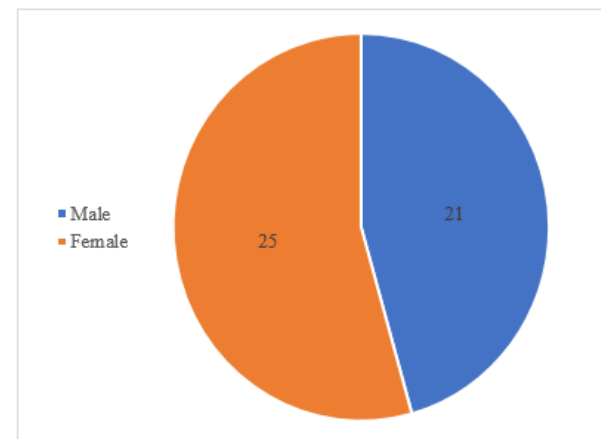


Figure 2: Side effects of Atropine.

Table 4 compared axial length (AL) between the atropine and control groups in children aged 6–10 years at various follow-ups. At baseline and follow-ups at 3, 6 and 12 months, no significant differences were found in AL for either eye between the groups. However, by the final follow-up, the change in AL was significantly greater in the control group for both eyes ($p<0.0001$).

Table 5 compared axial length (AL) between the atropine and control groups in children aged 11–14 years across different follow-ups. At baseline and at follow-ups at 3, 6 and 12 months, no significant differences in AL were observed between the groups for either eye. However, by the final follow-up, the increase in AL was significantly greater in the control group for both eyes ($p<0.0001$).

The pie chart showing the side effects of 0.01% atropine. It indicates that 4.5% of participants experienced temporary photophobia, which was improved by photo refractive glasses, while 95.5% had no side effects.

Table 1: Comparison of age and sex among group.

Sociodemographic characteristics	Atropine group (n=22)	Control group (n=24)	P value
Age (in years)			
6–10	12 (54.5%)	12 (50.0%)	0.758 ^a (NS)
11–14	10 (45.5%)	12 (50.0%)	
Mean±SD	10.77±1.92	10.67±1.85	0.850 ^a (NS)
Sex			
Male	10 (45.5%)	11 (45.8%)	0.979 ^b (NS)
Female	12 (54.5%)	13 (54.2%)	

^a Unpaired t-test was done to measure the level of significance, NS=Non-significant, ^b Chi-square test was done to measure the level of significance. The figure within parentheses indicates in percentage.

Table 2: Comparison of refractive status (Spherical equivalent) in different follow-ups between atropine and control group among age between 6-10 years.

Refractive status (D)	Atropine group (n=22)	Control group (n=24)	P value
Baseline at day 1			
Right eye	-1.92 ± 0.79	-1.96±0.58	0.317 ^{NS}
Left eye	-1.94±0.84	-1.92±0.56	0.874 ^{NS}
Follow up at 4 months			
Right eye	-1.92±0.79	-1.96±0.58	0.440 ^{NS}
Left eye	-1.94±0.84	-1.92±0.56	0.515 ^{NS}
Follow up at 6 months			
Right eye	-1.92±0.79	-1.96±0.58	0.440 ^{NS}
Left eye	-1.94±0.84	-1.91±0.56	0.541 ^{NS}
Follow up at 12 months			
Right eye	-1.96±0.84	-2.33±0.49	0.055 ^{NS}
Left eye	-1.96±0.86	-2.27±0.47	0.265 ^{NS}
Changes in refractive status after last follow-up			
Right eye	-0.04± 0.09	-0.38±0.23	<0.0001 ^S
Left eye	-0.02±0.07	-0.35±0.27	<0.0001 ^S

S= Significant obtained from unpaired t test, NS=Non-significant.

Table 3: Comparison of refractive status (Spherical equivalent) in different follow-ups between atropine and control group among age between 11-14 years.

Refractive status (D)	Atropine group (n=22)	Control group (n=24)	P value
Baseline at day 1			
Right eye	-1.00±2.19	-1.75±0.54	0.317 ^{NS}
Left eye	-1.70±1.25	-1.67±0.49	0.874 ^{NS}
Follow up at 3 months			
Right eye	-1.20±2.12	-1.75±0.54	0.440 ^{NS}
Left eye	-1.93±0.99	-1.67±0.49	0.515 ^{NS}
Follow up at 6 months			
Right eye	-1.20±2.12	-1.75±0.54	0.440 ^{NS}
Left eye	-1.95±1.00	-1.71±0.45	0.541 ^{NS}
Follow up at 12 months			
Right eye	-1.20±2.20	-2.27±0.62	0.055 ^{NS}
Left eye	-2.00±1.12	-2.18±0.53	0.265 ^{NS}
Changes in refractive status after last follow-up			
Right eye	-0.20± 0.72	-0.52±0.22	0.160 ^{NS}
Left eye	-0.30±0.71	-0.52±0.23	0.316 ^{NS}

NS= Non-significant obtained from unpaired t test.

Table 4: Comparison of axial length (AL) in different follow-ups between atropine and control group among age between 6-10 years.

Axial length(mm)	Atropine group (n=22)	Control group (n=24)	P value
Baseline at day 1			
Right eye	24.43±1.06	24.72±0.84	0.322 ^{NS}
Left eye	24.40±1.03	24.69±0.83	0.240 ^{NS}
Follow up at 3 months			
Right eye	24.43±1.06	24.74±0.85	0.301 ^{NS}
Left eye	24.40±1.03	24.71±0.83	0.225 ^{NS}
Follow up at 6 months			
Right eye	24.45±1.07	24.78±0.85	0.558 ^{NS}
Left eye	24.41±1.03	23.09±5.90	0.608 ^{NS}
Follow up at 12 months			
Right eye	24.46±1.08	24.92±0.84	0.102 ^{NS}
Left eye	24.43±1.04	24.92±0.82	0.132 ^{NS}
Changes in Axial length after last follow-up			
Right eye	0.03±0.02	0.21±0.05	<0.0001 ^S
Left eye	0.03±0.02	0.22±0.05	<0.0001 ^S

S=Significant obtained from unpaired t test, NS=Non-significant.

Table 5: Comparison of Axial length (AL) in different follow-ups between atropine and control group among age between 11-14 years.

Axial length(mm)	Atropine group (n=22)	Control group (n=24)	P value
Baseline at day 1			
Right eye	24.49±0.95	24.70±0.48	0.322 ^{NS}
Left eye	24.34±1.00	24.63±0.44	0.240 ^{NS}
Follow up at 3 month			
Right eye	24.50±0.96	24.71±0.49	0.301 ^{NS}
Left eye	24.35±1.00	24.65±0.45	0.225 ^{NS}
Follow up at 6 months			
Right eye	24.52±0.98	23.10±0.89	0.558 ^{NS}
Left eye	24.34±1.01	24.73±0.45	0.608 ^{NS}
Follow up at 12 months			
Right eye	24.54±0.98	24.89±0.49	0.102 ^{NS}
Left eye	24.36±1.02	24.84±0.44	0.132 ^{NS}
Changes in Axial length after last follow-up			
Right eye	0.04±0.05	0.20±0.05	<0.0001 ^S
Left eye	0.02±0.01	0.21±0.04	<0.0001 ^S

S= Significant obtained from unpaired t test, NS=Non-significant.

DISCUSSION

This hospital-based prospective comparative study assessed the efficacy of 0.01% atropine eye drops in slowing myopia progression and axial length growth in children aged 6 to 14 years. The atropine and control groups were well-matched, with no significant differences in age ($P=0.758$) or sex distribution ($P=0.979$), minimizing potential bias. Prior studies, such as, reported similar age and sex distributions, reinforcing the reliability of results. Proper matching is crucial, as younger children experience faster myopia progression and some studies indicate sex-based differences.⁵ At baseline and early follow-ups, refractive status remained comparable between the atropine and control groups across all ages. By the 12-months follow-up, children

aged 6–10 years in the atropine group showed significantly lower myopia progression (-0.04 ± 0.09 D vs. -0.38 ± 0.23 D, $p<0.0001$). Among older children (11–14 years), myopia progression was slower in the atropine group (-0.20 ± 0.72 D vs. -0.52 ± 0.22 D), but the difference was not statistically significant ($p>0.05$). These results highlight greater efficacy of atropine in younger children, who typically experience faster ocular growth. Prior studies, such as those by Chia et al, and Moriche-Carretero et al, also found younger children to benefit more from atropine treatment with greater reductions in myopia progression compared to older children.^{5,9} Axial length elongation was significantly lower in the atropine group across all ages. In children aged 6–10 years, AL change was 0.03 ± 0.02 mm vs. 0.21 ± 0.05 mm in the control group ($p<0.0001$). Among older children (11–14

years), AL elongation was reduced in the atropine group (0.04 ± 0.05 mm vs. 0.20 ± 0.05 mm, $p < 0.0001$), though the effect size was smaller. These findings align with Chia et al and Sen et al, (2022), which highlight faster axial growth in younger children and a stronger response to atropine.^{5,10} Subgroup analysis highlights the importance of early intervention, as younger children (6–10 years) face a higher risk of rapid myopia progression and axial length elongation, making them ideal candidates for atropine treatment. While older children (11–14 years) still benefit, the effect is less pronounced due to naturally slower progression. The findings align with prior studies, including Chia et al, which demonstrated significantly greater reductions in myopia progression and axial elongation in younger children.⁵ Compared to larger studies like Chia et al and Sen et al, the changes observed in refractive status and axial length over 12 months were less pronounced, likely due to differences in sample size, population characteristics, follow-up duration and environmental factors such as reduced outdoor activity and increased screen time.^{5,10} Atropine 0.01% was well-tolerated, with only 4.5% of participants experiencing temporary photophobia, effectively managed with photochromic lenses. These results are consistent with Sacchi et al, who reported a slightly higher photophobia incidence (8.9%) in European children. The low incidence of side effects supports atropine's safety for myopia control, particularly in younger children, where benefits outweigh minimal risks.

These findings advocate for incorporating low-dose atropine into pediatric ophthalmology, particularly for younger children at high risk for rapid progression. Early intervention can prevent complications such as high myopia, retinal detachment and glaucoma. Older children may still benefit, though to a lesser extent. Age-specific strategies are essential for effective myopia management and future research should investigate long-term effects and combination therapies, such as atropine with optical treatments, to enhance outcomes further. The relatively small sample size may affect the generalizability of the findings to a wider population. Additionally, the 12-month follow-up period may not be sufficient to evaluate the long-term effects of 0.01% atropine on myopia progression and axial length growth.

CONCLUSION

The study demonstrated that topical atropine 0.01% significantly reduces myopia progression and AL elongation, with younger children (6–10 years) benefiting the most. The findings emphasize the critical importance of early intervention to achieve optimal outcomes. Older children (11–14 years) also experienced reduced

progression, albeit to a lesser degree, highlighting the continued utility of atropine across age groups.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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