Topical atropine in retarding myopia progression and axial length growth in children with myopia

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Abstract

This study was conducted to observe the effect of atropine in retarding myopia progression and axial length growth in 36 myopic children (atropine group, 24; control, 12). The initial spherical equivalent of the atropine group and control group was -3.0 ± 1.6 dioptre and -3.5 ± 1.6 dioptre respectively. At the 12th month in atropine group, it was -2.9 ± 2.6 dioptre and -4.6 ± 1.9 dioptre in the control group. The power of the atropine group reduced but rose in the control group after 12 months. There was a statistically significant difference in final refractive errors between the two groups ($p<0.05$). The initial axial length of the atropine group and control group was 24.3± 1.0 mm and 24.6 ± 1.1 mm respectively. In 12th month, the changes in axial length in the two groups was insignificant. However, the mean axial length progression at 12 months of the atropine group was -0.1 ± 0.1 mm and it was lower than the control group which was -0.2 ± 0.2 mm, and this was statistically significant ($p<0.05$). In conclusion, topical atropine (0.01%) retarded myopia progression and axial length growth in myopic children.

Introduction

Myopia is a significant public health problem and its prevalence is increasing over time. Worldwide, the prevalence of myopia has been rising dramatically, and it is estimated that 2.5 billion people will be affected with myopia by 2020 and about half of the world population will be myopic, with 10% of them highly myopic by 2050.[1,2]

The absolute risk of severe visual impairment is 30% in individuals with an axial length of 26 mm and increases up to 95% in those with an axial length of 30 mm or more. The risk of these complications increases with the severity of myopia. Progressive myopia when it reaches high myopia (<−6 dioptre; axial length ≥26 mm), increases the risk of severe blinding complications, such as myopic macular degeneration, retinal detachment, and glaucoma.[3,4]

Current treatment options for progressive myopia can be categorized into conservative and pharmacological interventions.[5] The effects of the conservative regimens, except for the orthokeratology, are relatively small.[6] However, pharmacological intervention with atropine eye drop has a much higher efficacy in the treatment of myopia progression.[7]

Atropine, a non-selective muscarinic receptor antagonist, is one of the most researched drugs for the intervention of progressive myopia.[8] Because myopia commonly develops in childhood and stabilizes after a period of progression, it may be possible to reduce the lifetime risk of retinal complications by reducing the severity of final myopia with an effective treatment modality targeting children with myopia.[9-13] This study was carried out to evaluate the effectiveness of 0.01% atropine eye drop in retarding myopia progression and axial length growth in myopic children so that this pharmacological agent could be adopted as a treatment option to reduce the severity of final myopia.

Materials and Methods

This randomized-controlled trial study was conducted from January to December 2017 in the Outpatient Department of Ophthalmology, Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka, Bangladesh.

The patients and patient's guardians were informed verbally about the study design, the purpose of the study, and their right to withdraw from the study at any time, for any reason, whatsoever before selection. After informed written consent was given from patient's parents and guardians and assent from the patient, the patients were selected for the study. Confidentiality and privacy were

maintained throughout the study.

In total 36 participants (children of age range: 6 to 18 years) with myopia were enrolled for the as per inclusion and exclusion criteria. Inclusion criteria: a) Spherical equivalent of refractive status range −0.5 D to −5.5 D; b) Children of the age group of 6 to 18 years old. Exclusion criteria: a) Refractive status > -5.5D; b) Astigmatism greater than −2.0 D; c) Anisometropia greater than 2.0 D; d) Children with other ocular diseases, such as amblyopia, strabismus, infantile glaucoma, congenital cataract, optic nerve atrophy, corneal opacity, traumatic eye injury, uveitis, and ocular tumor; e) History of intraocular surgery; f) Any systemic disease that may affect visual function and development, such as diabetes mellitus; and e) Poor compliance with the change of topical medications during follow-ups, based on chart record.

The 36 patients were divided into two groups: 24 patients who received 0.01% atropine eye drop as the atropine group and 12 myopic patients who received artificial eye drops as the control group.

The atropine group was given an atropine eye drop once daily for 12 months and the control group was given artificial tear drop once daily for 12 months. Proper instructions were given to the patient's parents and guardians about the procedure of eye drop application and compliance. Atropine eye drop of 0.01% was prepared by adding 2 drops of 1% atropine eye drop in 10 mm an artificial eye drop (Protear eye drop). Atropine eye drop of the brand name Atropine OSL® (manufacturer: Opso Saline Ltd, composition: Atropine sulfate 1%, Batch No. EFF 007) was used. Artificial eye drop of the brand name Protear eye drop (manufacturer: Aristo -pharma Ltd. with composition: Povidone BP 50 mg + Electrolytes and benzalkonium chloride 0.05 mg as preservative) was used.

Data were recorded using a structured questionnaire containing all the variables of interest.

Eye examination was conducted as follows: A standardized ophthalmological examination was performed at baseline and at 12 months after the initiation of atropine treatment. At baseline, full cycloplegia was obtained 45 min after administration of 1% cyclopentolate eye drop. During follow up cycloplegia was already present at the time of examination due to the use of atropine; this was confirmed by dynamic retinoscopy with a Heine beta 200 retinoscope (Heine Optotechnik, Germany), and was therefore considered a measure of compliance. During both baseline and follow-up at 12 months, the refractive error was measured in spherical equivalent with a Topcon autorefractor KR8900 (Topcon, Japan) and the spherical equivalent was calculated using the standard formula:

Spherical equivalent = Sphere + 1/2 cylinder

During each visit, IOL Master 500 (Carl Zeiss MEDITEC IOL-master, Germany) was used to measure Axial length in millimeters.

Statistical analysis

Data were analyzed using Statistical package for social science (SPSS) version 21.0 for windows (USA). P value >0.05 indicates not significant.

Results

The initial refractive error of the atropine group was -3.0 ± 1.6 dioptre, whereas that of control group was -3.5 ± 1.6 dioptre. There was no statistically significant difference (p>0.05) in the mean initial refractive errors between the two groups. After 1 year of the study refractive error at 12th month for the atropine group and the control group was -2.9 ± 2.6 dioptre and -4.6 ± 1.9 diopter respectively. There was a statistically significant difference in the final refractive error between the two groups (p<0.05). The annual change of refractive error of the atropine group was -0.5 ± 2.4 dioptre, whereas that of the control group was -0.4 ± 0.4 dioptre. The annual change in the refractive errors between the two groups was not statistically significant (p>0.05) (Table I).

Table I

Distribution of the biometric parameters of spherical equivalent and axial length over time

Time	Spherical equivalent (dioptre)			Axial length (mm)		
	Atropine (n=24)	Control (n=12)	p value	Atropine (n=24)	Control (n=12)	p value
0 month	-3 ± 1.6	-3.5 ± 1.6	0.294^{ns}	24.3 ± 1.0	24.6 ± 1.1	0.415^{ns}
12th month	-2.9 ± 2.6	-4.6 ± 1.9	0.015^{s}	24.4 ± 1.1	25.0 ± 1.2	0.136^{ns}
Change at 12th month	-0.5 ± 2.4	0.4 ± 0.4	0.891^{ns}	-0.1 ± 0.1	-0.2 ± 0.2	0.044^{s}
%Change	8.7 ± 66.5	-11.4 ± 10.3	0.865^{ns}	-0.5 ± 0.5	-1.0 ± 1.0	0.054^{ns}

Data are mean ± SD; s= significant , ns= not significant; p value calculated by unpaired t-test

The initial axial length was 24.3 ± 1.0 mm in the atropine group and 24.6 ± 1.1 mm in the control group. The final axial length after 12 months was 24.4 ± 1.1 mm in the atropine group and 25.0 ± 1.2 mm in the control group. There was no significant difference in the final axial length between the two groups ($p>0.05$). The annual change of axial length from baseline was -0.1 ± 0.1 mm in the atropine group and -0.2 ± 0.2 mm in the control group and the results were statistically significant ($p<0.05$) between the two groups (Table I)

Discussion

The present study has shown that 0.01% of atropine eye drop has a role in the retardation of myopia progression and axial length growth in children with myopia. The refractive error at the 12th month in this study in the atropine group was - 2.9 ± 2.6 dioptre and in the control group was - 4.6 ± 1.9 dioptre and these results were statistically significant ($p<0.05$). The annual change of refractive error in this study found in the atropine group was -0.5 ± 2.4 dioptre and in the control group was +0.4 ± 0.4 dioptre was not statistically significant ($p> 0.05$), the annual change of axial length from baseline was -0.1 ± 0.1 mm in the atropine group and -0.2 ± 0.2 mm in the control group and the results were statistically significant ($p<0.05$).

This study found that myopia reduced in the atropine group while in the control group myopia increased indicating myopia progressed in the control group. This contributed to a decrease in axial length growth in the atropine group because axial length is directly proportional to myopia, and the finding was similar to a previous study.[14]

Another study from Singapore used various concentrations of atropine (0.5%, 0.1%, and 0.01%), to slow myopia progression and found that the effect of atropine was best seen in the higher concentrations in the atropine group participants which implied that the effect of atropine may be dose-dependent but higher concentrations of atropine showed more adverse effects, such as photophobia due to mydriasis and blurring of near vision from induced cycloplegia. On the other hand like the present study, their study also found that 0.01% atropine was effective in reducing myopia progression with minimal adverse effects.[15]

It was postulated by previous studies that atropine interferes with myopia progression by local effect (suppressing dopamine neurotransmitter and retinal growth) and systemic effect (suppressing growth hormone secretion from the pituitary gland) and also includes receptor binding on different ocular tissue at multiple levels to control myopia.[4, 16-19]

Myopia places an individual at an increased risk of sight-threatening diseases, including glaucoma (open-angle), cataract (nuclear, cortical and posterior subcapsular), and rhegmatogenous retinal detachment. The incidence of these conditions is greatest in an individual whose myopia progressed to high myopia (refractive error <-6 dioptre, axial length ≥ 26 mm).[3,4]

Conclusion

It seems from the results that 0.01% atropine is effective in retarding myopia progression and axial length growth in myopic children.

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Ethical Issue

The protocol for this study was approved by the Institutional Review Board of Bangabandhu Sheikh Mujib Medical University. Every child gave assent and informed written consent was taken from parents and legal guardians of the children who participated in the study.

Conflict of Interest

Authors declare no conflict of interest

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