Convergence excess consecutive esotropia associated with 0.01% atropine eye drops usage in patients operated for intermittent exotropia

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To report convergence excess esotropia (CEET) following 0.01% atropine eye drops (Low dose atropine [LDA]). Children who developed CEET that resolved promptly after discontinuation of LDA are described. Three myopes aged 5.3 ± 1.2 years and mean sphere -4.5D were included. All were operated for intermittent exotropia earlier. Mean esotropia was +28.3PD for near and 10.6PD for distance. LDA induced high AC/A ratio and fusion normalized in 3 weeks after discontinuation of LDA. LDA should be used with caution in patients with esophoria or previously operated for intermittent exotropia. Any evidence of the emergence of a CEET should warrant discontinuation of LDA.

Key words: Anticholinergic, atropine, convergence excess, esotropia, progressive myopia

According to recent studies, 0.01% atropine eye drop (LDA) has become popular first-line treatment for progressive childhood myopia.[1,2] In spite of +3D to +6D decrease in accommodation with LDA, hypoaccommoadtion is seldom of any clinical concern.[3,4]

In this study, we present hitherto unreported complication of LDA induced convergence excess esotropia (CEET) due to hypoaccommodation following its application once at night. The esotropia promptly normalized and the fusion was restored in all the children after discontinuation of LDA.

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Case Reports

Patient 1: A 6-year-old boy, who underwent bilateral lateral rectus recession of 7.5 mm and inferior oblique weakening for basic type intermittent exotropia with V-pattern, a year prior to starting LDA, developed CEET following its use. His esotropia measured +18PD for distance and +35 PD for near that reduced to +14PD esophoria for distance and +16 PD esophoria for near after discontinuing LDA [Fig. 1 and Table 1]. Peripheral fusion was found to be restored on Bagolini striated glasses. Prior to the use of LDA, he had orthotropia for the near, flick esotropia (+4PD) for the far, and peripheral fusion was present.

Patient 2: A 6-year-old girl, already on LDA, underwent bilateral lateral rectus recession of 7 mm for intermittent exotropia with tenacious proximal fusion. She was orthotropic for near and +8PD esotropic for distance postoperatively. The LDA was discontinued on the day of surgery and resumed 2 weeks post-surgery; post 1 month of following she developed +2PD esotropia for distance and +25PD for near that recovered to orthotropia after its discontinuation [Fig. 2 and Table 1]. Her fusion was also restored.

Patient 3: A 4-year-old girl using LDA for 3 months, underwent left eye lateral rectus recession of 7.5 mm and medial rectus resection of 5 mm with bilateral inferior oblique weakening for basic type intermittent exotropia with V-pattern. Postoperatively she had orthotropia for distance and +4PD esotropia for near. She resumed LDA 2 weeks after surgery. One month later, she developed +12PD esotropia for distance and +25PD esotropia for near. Three weeks after stopping LDA, her near esotropia was reduced to +12PD [Fig. 3] and peripheral fusion was restored.

LDA was effective in retarding the myopia progression in all the patients [Fig. 4].

Table 1: Clinical profile of the patients who developed esotropia with LDA

	Patient 1	Patient 2	Patient 3
Age in years	6	6	4
Gender	Male	Female	Female
Right eye sphere in diopters	-6.50	-2.25	-3.50
Left eye sphere in diopters	-7.00	-2.0	-4.0
Best corrected distance visual acuity (log MAR)	0.1	0	0.1
Total duration of use of LDA	16 months	4 months	4 months

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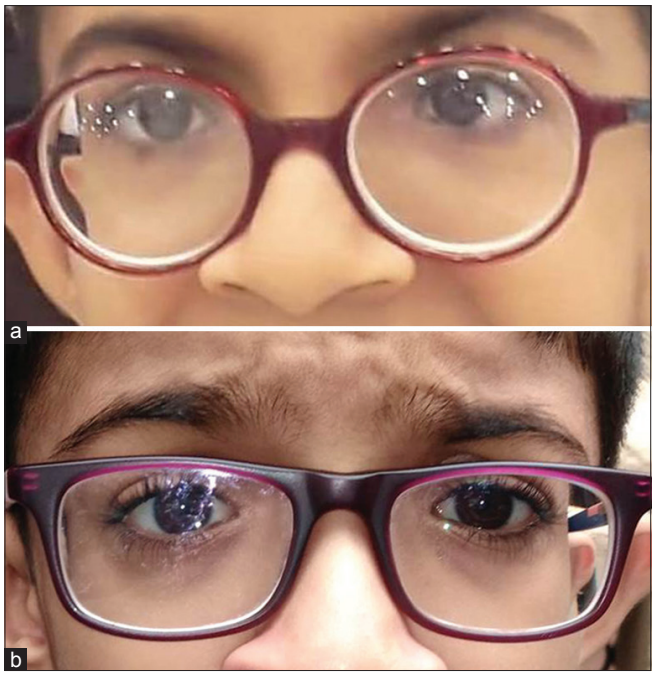

Figure 1: Picture of 6-year-old boy with 0.01% atropine induced esotropia in the left eye (a) and resolution after stopping (b)

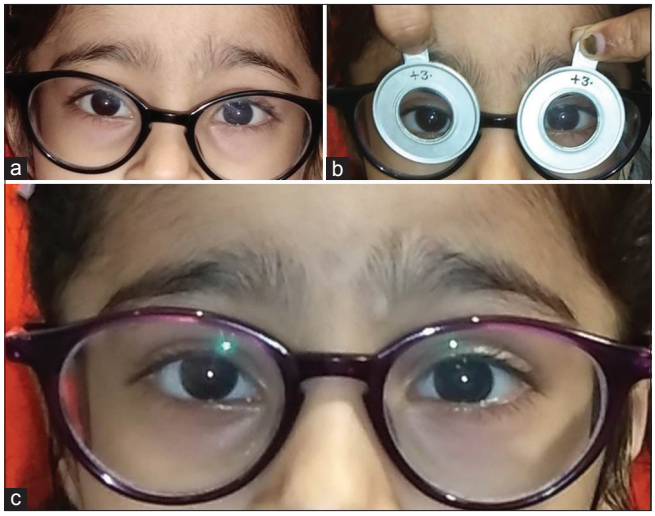

Figure 3: Picture of 4-year-old girl with 0.01% atropine induced esotropia in the left eye (a), an immediate resolution with +3.0D add (b) and resolution after discontinuation (c)

Accommodation improved in patient 1 and patient 2 after stopping LDA [Table 2]. However, binocular and monocular accommodative functions could not be measured in patient 3.

Discussion

A modest reduction in accommodation in children using LDA is common and generally well tolerated.[2-6] However, the accommodative abnormalities induced due to long-term use of LDA may affect accommodation and convergence relationship resulting in CEET in children, especially with pre-existing fusional anomalies.

Figure 2: Picture of 6-year-old girl with 0.01% atropine induced esotropia in the right eye (a) and resolution after discontinuation (b)

In our study, bedtime instillation of LDA in the patients, who were monofixators postoperatively, resulted in hypoaccommodation induced excessive innervational drive to accommodate, leading to manifest esotropia with an increased AC/A ratio causing decompensation of their tenuous fusion. Similarly, a previous study by Lyu, *et al*.[7] reported a median increase of +10PD in 38% of children with pre-existing esodeviation under the effect of partial cycloplegia using 0.5% tropicamide and 0.5% phenylephrine. A maximum increase of +25PD was reported which recovered after the effect of cycloplegia subsided. A similar phenomenon (CEET) was observed with the use of systemic anticholinergics viz. scopolamine patch for sialorrhoea in cerebral palsy,[8] amitriptyline and oxybutynin for nocturnal enuresis,[9-11] and haloperidol and benzatropine mesylate for Tourette syndrome.[12]

The AC/A ratio is believed to be inborn and remains constant throughout life but varies greatly amongst individuals.[13] Cycloplegic agents interfere with accommodation but if it is retained due to incomplete cycloplegia, it induces a reflex convergence by excessive innervational accommodative effort, thus increasing esodeviation.[14] Conversely, if cycloplegia is complete and present for an extended duration, accommodative efforts are suspended causing complete abolition of an accommodative component of esotropia. This is typically seen with the use of 1% atropine drops in patients with fully refractive accommodative esotropia [Fig. 5].[15]

Some factors that were common in all our patients and previous studies were 1) pre-existing esophoria and 2) prompt reduction in esotropia after discontinuation of the drops. Although two patients in our study were left with significant esotropia, future follow-ups may show a further reduction of esotropia provided their LDA is stopped. Inability to recognize this side effect of LDA could cause permanent contracture of medial rectus leading to incomplete resolution of esotropia despite its discontinuation. Such a phenomenon

Table 2: Improvement in accommodative functions after cessation of 0.01% atropine eye drops in patients with convergence excess esotropia

	On Low dose Atropine	After stopping low dose atropine
Patient 1:		
Negative relative Accommodation	+4	+4
Positive relative accommodation	-1.50	-2.50
Binocular accommodation facility	8 cycles per minute (cpm)	>15 cpm
Right eye accommodation facility	3 cpm	14 cpm
Left eye accommodation facility	3 cpm	14 cpm
Patient 2:		
Near vision	N6	N6
Binocular accommodation facility	Not reliable	Not reliable
Binocular near point of accommodation	14 cm	12 cm
Right and left eye monocular near point of accommodation	14 cm	12 cm

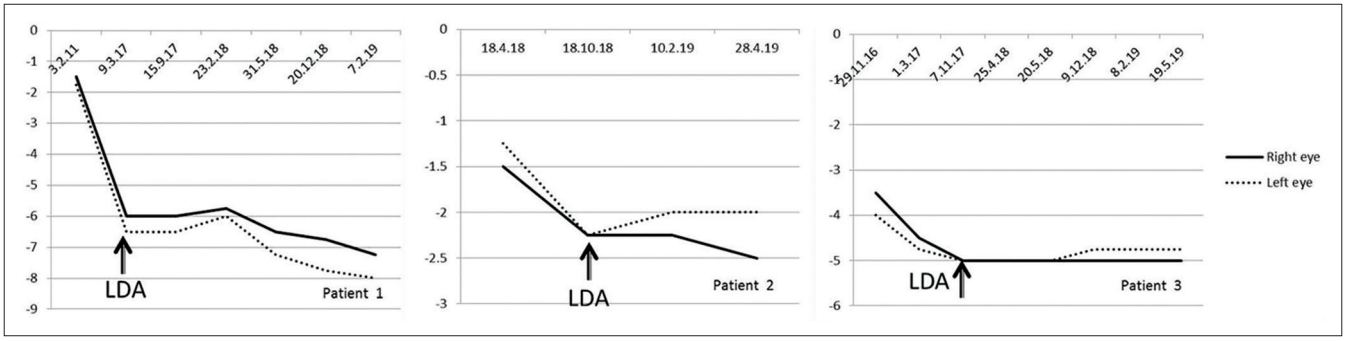

Figure 4: Line diagram demonstrating the effectiveness of 0.01% atropine (LDA) in patients with CEET

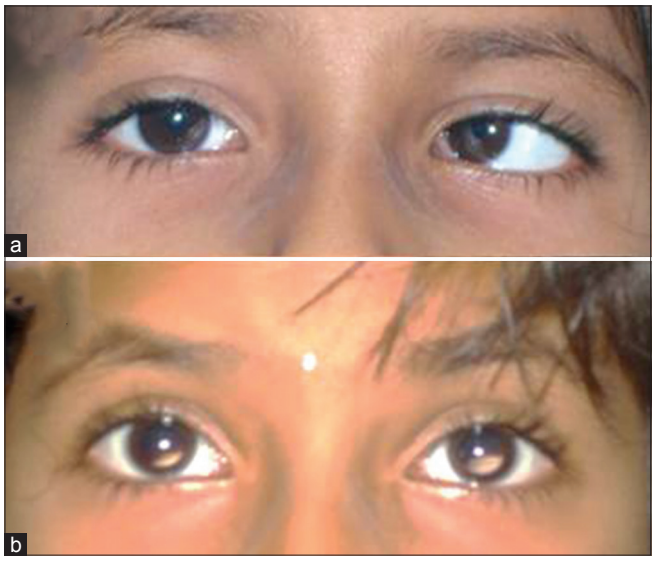

Figure 5: Picture of 5-year-old girl with fully refractive accommodative esotropia in the left eye (a) and resolution after extended and complete cycloplegia produced with 1% atropine eye ointment (b)

is often reported in presbyopes, which could happen due to defects in vergence adaptation (neurologic) or muscle length adaptation (anatomic).[16] Because the children were young, no forced duction test (FDT) was performed on medial rectus. Inference of a positive FDT is that the long-term use of LDA caused muscle length adaptation (medial rectus shortening) in response to increased accommodative effort induced convergence excess.

Although none of our patients had convergence excess type of intermittent exotropia preoperatively, it is advisable to discontinue LDA in such patients scheduled for squint surgery.

The last point of contention is possible therapeutic use of LDA for patients with low AC/A ratio viz. convergence insufficiency. Similar to once used cholinergic agents viz echothiopate, carbachol, and isoflurophate for convergence excess esotropia, it is possible that LDA may improve AC/A ratio in patients with convergence insufficiency. This question is best left for future research.

To summarize, LDA should be used cautiously and after a detailed discussion with the parents regarding it's off label use for retardation of myopia progression more so in the patients having pre-existing fusional anomalies (or other ocular comorbidity). Any evidence of the development of a CEET or any other side effect should warrant immediate discontinuation of LDA. Further research is needed to determine whether bifocal glasses or progressive addition lenses with LDA or switching to 1% atropine eye drops could prevent a recurrence of CEET while retaining the therapeutic benefits of atropine.[17,18]

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients

understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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