Brief Communications

# Use of atropine to predict the accommodative component in esotropia with hypermetropia

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This cohort study included children with esotropia and hypermetropia of ≥ +2.0 diopters (D). The deviation was measured at presentation, under atropine cycloplegia and 3 months after full refractive correction. Of 44 children with a mean age of 5.2 ± 2.4 years, 25 were males. Eighteen (41%) had fully refractive accommodative esotropia (RAE), 10 (23%) had partial accommodative esotropia (PAE), and 5 (11%) had nonaccommodative esotropia (NAE). Eleven (25%) had convergence excess (CE). Under cycloplegia, all with RAE and RAE with CE had orthotropia. There was no significant change in the deviation in the patients with NAE. The deviation under cycloplegia and that with full refractive correction in PAE and PAE with CE (with +3.0 D addition) were not different. The intraclass correlation coefficient for deviation under cycloplegia and after full refractive correction (+3.0 D addition for CE) was 0.89. It was concluded that ocular deviation under cycloplegia can help to predict the accommodative component in esotropia with hypermetropia.

**Key words:** Accommodative esotropia, atropine, cycloplegia, esotropia

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Childhood esotropia is commonly associated with significant hypermetropia. Depending upon the effect of spectacle correction, esotropia is further classified.[1] If significant esotropia persists despite refractive correction, a prompt surgical correction offers a better chance to restore binocularity and stereoacuity.[2-4] This study was performed to test our hypothesis that cycloplegia abolishes the accommodative component of esotropia that helps to anticipate the effect of refractive correction on the ocular deviation. Literature search did not reveal a pertinent peer reviewed study.

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## Materials and Methods

This cohort study included 44 consecutive patients with the following inclusion criteria: (1) age 1–16 years, (2) comitant esotropia ≥ 12 prism diopters (Δ), (3) hyperopia ≥ +2.0 diopters (D; spherical equivalent), (4) patients cooperative for reliable measurement of ocular deviation, (5) minimum 3-month follow-up, and (6) 100% compliance to spectacle wear. Exclusion criteria were (1) associated ocular comorbidity, namely, coloboma, nystagmus, albinism, or cataract, (2) poor fixation, and (3) systemic abnormalities, namely, birth asphyxia, cerebral palsy, or Down's syndrome.

Deviation was measured with the prism cover test using the age appropriate accommodative target for near (40 cm) and distance (6 m). The measurements were taken at (1) presentation, without optical correction and without cycloplegia; (2) after 3 days, under complete cycloplegia, without optical correction; and (3) after 3 months of spectacle wear with full refractive correction and without cycloplegia.

In patients with convergence excess (CE), the near deviation was measured with +3.0 D addition. In children < 3 years ($n = 7$), the corneal reflex test by Krimsky's method was utilized to measure the distance deviation.

Cycloplegia was achieved with 1% atropine eye ointment applied twice a day for 3 days and once on the day of examination (fourth day).

A child was diagnosed with refractive accommodative esotropia (RAE) if the deviation was corrected to <10 Δ with spectacles [Fig. 1]; partial accommodative esotropia (PAE) if there was a significant reduction of the deviation (≥10 Δ) with spectacles, yet there was a residual esotropia of ≥10 Δ [Fig. 2]; and nonaccommodative esotropia (NAE) if spectacle correction did not have a significant effect on the deviation [Fig. 3]. CE was diagnosed when the near deviation exceeded the distance deviation by ≥8 Δ [Figs. 4–6].

The ocular deviation under cycloplegia was compared with the ocular deviation after spectacle correction (+3.0 D addition for the near in patients with CE). Pearson's correlation coefficient ($r$) and intraclass correlation coefficient (ICC)[4] were calculated to assess the correlation.

The sample size was calculated using the formula $N = (z_{1-\alpha/2} - z_{1-\beta})^2 s_d^2/d^2$.[5] At 5% significance and 90% power of the study, to detect the difference of 4 Δ, with a standard deviation of difference 8 Δ, we needed 42 subjects.

## Results

Forty-four children aged 5.2 ± 2.4 years (SD, range 1–9) of whom 25 were males were included. RAE was the most common type of esotropia [Table 1]. All patients with RAE and RAE with CE had orthotropia under cycloplegia [Table 2]. In PAE, the deviation measured under cycloplegia was equal to that measured with full refractive correction. In PAE with CE, the deviation measured under cycloplegia was equal to that measured with full refractive correction

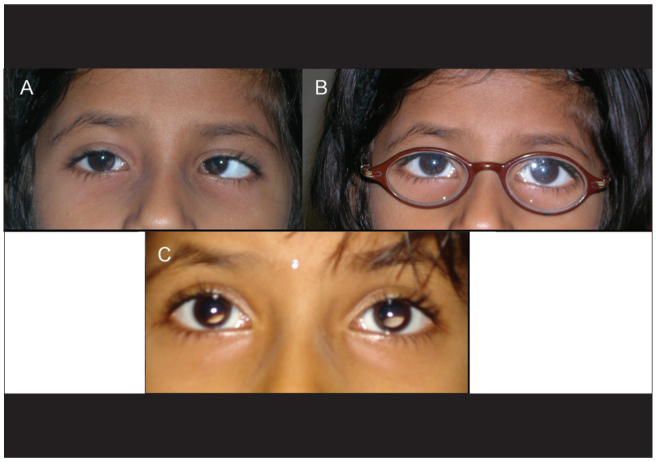

**Figure 1:** Serial face photographs of a child with RAE showing (A) left esodeviation without refractive correction, (B) orthotropia with full spectacle correction, and (C) orthotropia under cycloplegia

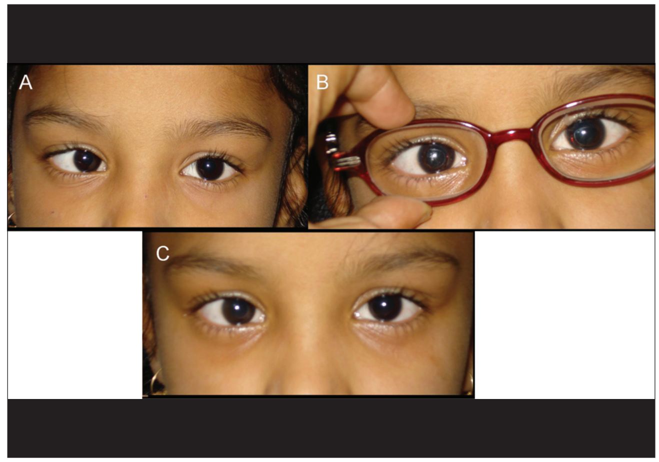

**Figure 2:** Serial face photographs of a child with PAE showing (A) right esodeviation without refractive correction, (B) residual esodeviation with spectacle correction, and (C) residual esodeviation under cycloplegia

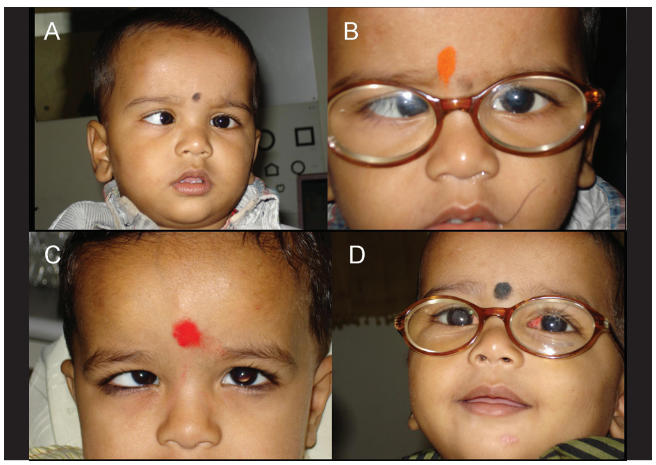

**Figure 3:** Serial face photographs of a child with NAE showing (A) right esodeviation without refractive correction, (B) no change in esodeviation with spectacle correction or (C) under cycloplegia, and (D) orthotropia after surgery

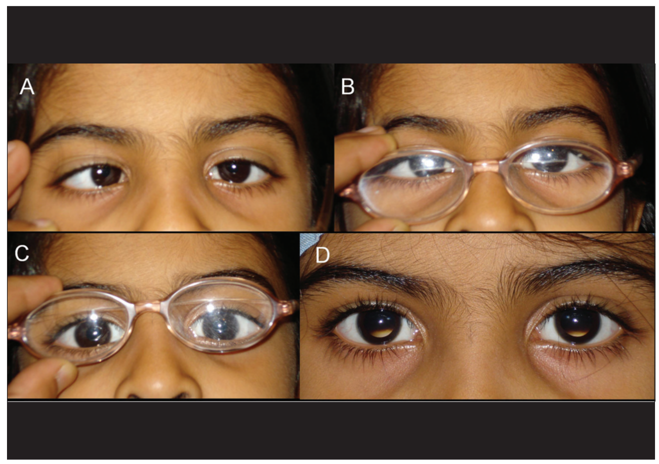

**Figure 4:** Serial face photographs of a child with refractive RAE with CE showing (A) right esodeviation without refractive correction, (B) reduced esodeviation with spectacle correction, (C) orthotropia with spectacle correction and +3.0 D addition, and (D) orthotropia under cycloplegia

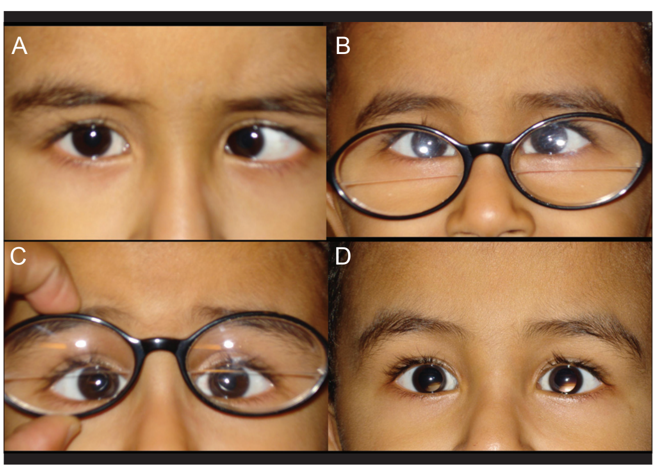

**Figure 5:** Serial face photographs of a child with PAE with CE showing (A) left esodeviation without refractive correction, (B) residual esodeviation with spectacle correction, (C) residual esodeviation with spectacle correction and +3.0 D addition, and (D) residual esodeviation under cycloplegia

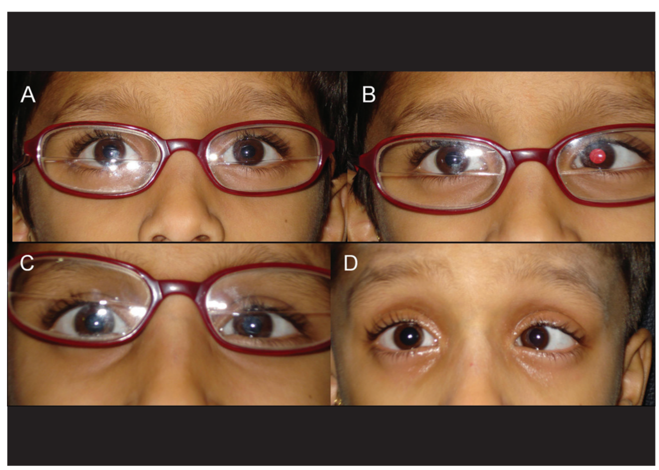

**Figure 6:** Serial face photographs of a child with NAE with CE showing (A) orthotropia for the distance (plano lens), (B) left esodeviation for the near (plano lens), (C) orthotropia with +3.0 D addition, and (D) left esodeviation under cycloplegia

**Table 1: Distribution and the angle of deviation of esotropic patients in various groups**

| *n* = 44 | Normal convergence | | Convergence excess | | | Total |
|---|---|---|---|---|---|---|
| | %, (*n*) | Angle of deviation (Δ) Mean ± SD (range) | %, (*n*) | Angle of deviation (Δ, distant) Mean ± SD (range) | Angle of deviation (Δ, near) Mean ± SD (range) | %, (*n*) |
| RAE | 41%, (18) | 37 ± 10 (14–50) | 18%, (8) | 40 ± 25 (20–100) | 51 ± 28 (30–120) | 59, (26) |
| PAE | 23%, (10) | 55 ± 20 (35–100) | 7%, (3) | 23 ± 15 (14–40) | 43 ± 8 (35–50) | 30, (13) |
| NAE | 11%, (5) | 42 ± 17 (20–65) | 0, (0) | NA | NA | 11, (5) |

RAE = refractive accommodative esotropia, PAE = partial accommodative esotropia, NAE = nonaccommodative esotropia, Δ = prism diopter, NA = not applicable

**Table 2: Age, refractive error, and ocular deviation in different groups of esotropia**

| *n* = 44 | RAE (*n* = 18) Mean ± SD (range) | RAE ± CE (*n* = 8) | PAE (*n* = 10) | PAE ± CE (*n* = 3) | NAE (*n* = 5) |
|---|---|---|---|---|---|
| Age (years) | 4 ± 2.1 (1–9) | 6.5 ± 2.4 (3–9) | 6 ± 2.6 (1.5–9) | 7 ± 1.0 (6–8) | 4.4 ± 1.8 (2–6) |
| Spherical equivalent (D) | 6.7 ± 1.7 (3.4–10) | 4.6 ± 1.5 (2.3–7.6) | 5.1 ± 2.5 (0–10) | 3.3 ± 1.4 (1–4.8) | 3.8 ± 1.4 (1.8–5.8) |
| Anisometropia (D) | 0.7 ± 0.6 (0–1.9) | 0.7 ± 0.6 (0–1.6) | 0.7 ± 0.9 (0–2.8) | 1 ± 2 (0–3) | 0.6 ± 0.6 (0.1–1.5) |
| Cover test (Δ) on presentation(near) | 37.2 ± 10.3 (14–50) | 46.9 ± 24.0 (25–100) | 54.5 ± 20.3 (35–100) | 61.7 ± 20.2 (50–85) | 42 ± 16.8 (20–65) |
| Cover test (Δ) on presentation(distant) | 36 ± 10.9 (14–50) | 41.7 ± 29.4 (20–100) | 55.6 ± 21 (35–100) | 55 ± 31.2 (30–90) | 37.5 ± 12.6 (20–50) |
| Cover test (Δ) under cycloplegia (near) | 0 ± 0 (0) | 0 ± 0 (0) | 26.9 ± 9.8 (18–40) | 24 ± 14.0 (14–40) | 39.6 ± 17.6 (20–68) |
| Cover test (Δ) under cycloplegia (distant) | 0 | 0 | 27.9 ± 9.8 (18–40) | 22.7 ± 15 (14–40) | 33.8 ± 9.5 (20–40) |
| Cover test (Δ) with full correction (near) | 0 | 13.1 ± 3.8 (8–18) | 26.9 ± 9.8 (18–40) | 43.3 ± 7.6 (35–50) | 38 ± 16.8 (20–65) |
| Cover test (Δ) with full correction(distant) | 0 | 0 | 27.9 ± 9.8 (18–40) | 23.3 ± 14.5 (14–40) | 32.5 ± 8.7 (20–40) |
| Cover test (Δ) with addition lens | NA | 0 | NA | 22.7 ± 15.5 (10–40) | NA |

RAE = refractive accommodative esotropia, PAE = partial accommodative esotropia, NAE = nonaccommodative esotropia, Δ = prism diopter, CE = convergence excess, NA = not applicable.

with +3.0 D addition. In the patients with NAE, the deviation measured under cycloplegia was same as that with spectacle correction.

A child with NAE with CE (nonaccommodative CE) with emmetropia (not included in the study) had orthotropia with the bifocals but esotropia for near under cycloplegia [Fig. 6].

*r* for the ocular deviation under cycloplegia and full refractive correction (with +3 D addition in the patients with CE) was 1.0. The ICC was excellent (0.89).

Three patients required oral medication for fever. None had to discontinue atropine.

## Discussion

An accommodative esotrope often has straight eyes when not accommodating. Similarly, under complete cycloplegia, the accommodative component of the esodeviation is eliminated. Hence the ocular deviation under cycloplegia was useful to predict the effect of spectacle correction on ocular deviation.

In a previous study, "in patients with RAE, hyperopic LASIK produced orthotropia when there was postoperative emmetropia and in patients with PAE, residual esotropia remained despite a postoperative emmetropia."[6]

We treated a 3-year-old child with RAE and amblyopia, whose esotropia disappeared after bilateral cataract surgery with intraocular lens implantation, despite a postoperative hyperopia of +1.75 D in both eyes.

It seems, in patients with accommodative esotropia, the central will to accommodate disappears with the full refractive correction of hyperopia/addition lenses if there is CE, after cataract extraction and under complete cycloplegia.

Complete cycloplegia for a prolonged duration is an absolute prerequisite for reliable measurements. With incomplete cycloplegia or shorter duration of cycloplegia, an accommodative effort may still be deployed resulting into an esodeviation. A clinician should routinely perform dynamic retinoscopy and give adequate time for the cycloplegia to persist.

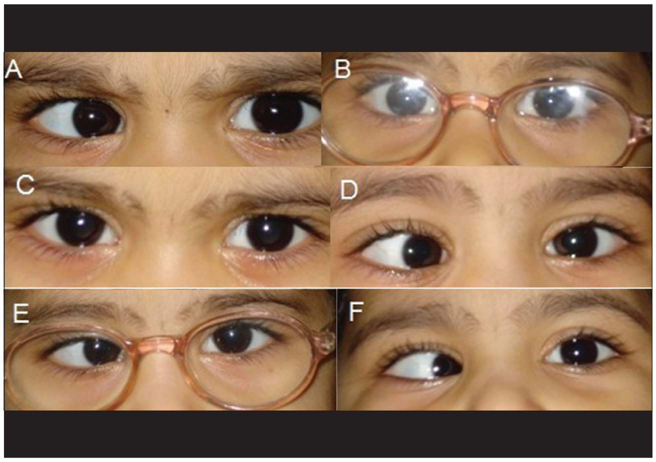


**Figure 7:** Serial face photographs of a child with decompensated RAE showing (A) right esodeviation without refractive correction, (B) orthotropia with full spectacle correction, and (C) orthotropia under cycloplegia. After decompensation, (D) right esodeviation without refractive correction, (B) right esodeviation with full spectacle correction, and (C) right esodeviation under cycloplegia

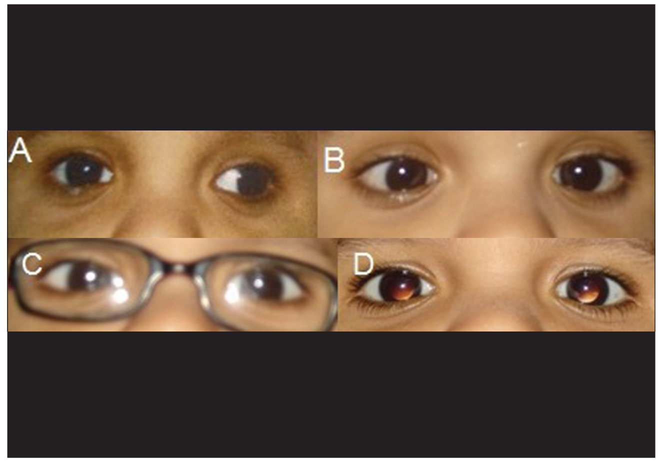


**Figure 8:** Serial face photographs of a child with consecutive RAE following a surgery for intermittent exotropia: (A) left eye exotropia, (B) right eye esotropia following the surgery (C), orthotropia with full spectacle correction, and (D) orthotropia under cycloplegia

In one patient with NAE with CE (hypoaccommodative convergence excess), the esotropia persisted under cycloplegia [Fig. 6]. We confirmed complete cycloplegia using dynamic retinoscopy and dynamic autorefractometry.[7] It was evident that atropine for three days was unable to abolish excessive convergence. A similar observation was reported by Nemet.[8] Probably the nonaccommodative/hypoaccommodative CE in these patients makes it impossible to block the convergence drive for near fixation even under cycloplegia after two days. Such patients need cycloplegia for a longer duration.

We examined two of the PAE patients nearly 3 years prior to their recruitment in this study. At that time, they had RAE. They demonstrated orthotropia under cycloplegia during the RAE stage and residual esotropia during the PAE stage. Another patient (not included in the study) had RAE that rapidly decompensated to NAE; she had orthotropia under atropine during the RAE stage and large esodeviation under atropine during the NAE stage [Fig. 7]. Another child with +6.0 D in both eyes and intermittent exotropia developed consecutive RAE; after squint surgery (not included in the study) he demonstrated an orthotropia with full refractive correction and under complete cycloplegia [Fig. 8]. In conclusion, cycloplegia abolished the accommodative component of esotropia. The measurement of deviation under cycloplegia could be helpful to differentiate the accommodative component from the nonaccommodative component in patients with esotropia and hyperopia.

Further studies are necessary to know whether or not the residual esotropia under cycloplegia will be controlled with fusional divergence once the deviation is reduced with spectacle correction and the effect of other cycloplegic agents.

## References

1. Von Noorden GK, Campos EC. Esodeviations. In: von Noorden GK, Campos EC, editors. Binocular Vision and Ocular Motility. Theory and management of strabismus. 6th ed. St. Louis: Mosby; 1990. p. 311-55.
2. American Academy of Ophthalmology. Preferred Practice Pattern. Amblyopia. Guidelines for prescribing eye glasses for young children; 2002. p. 6.
3. Birch EE. Marshall Parks lecture. Binocular sensory outcomes in accommodative ET. J AAPOS 2003;7:369-73.
4. Portney LG, Watkins MP. Correlation. In: Portney LG, Watkins MP, editors. Foundations of Clinical Research. Applications and Practice. 1st ed. Norwalk: Appleton and Lange; 1993. p. 509-16.
5. Naduvilath TJ, John RK, Dandona L. Sample size for ophthalmology studies. Indian J Ophthalmol 2000;48:245-50.
6. Polat S, Can C, Ilhan B, Mutluay AH, Zilelioğlu O. Laser *in situ* keratomileusis for treatment of fully or partially refractive accommodative esotropia. Eur J Ophthalmol 2009;19:733-7.
7. Manny RE, Chandler DL, Scheiman MM, Gwiazda JE, Cotter SA, Everett DF, *et al*. Accommodative lag by autorefraction and two dynamic retinoscopy methods. Optom Vis Sci 2009;86:233-43.
8. Nemet P. Ocular deviation under atropine cycloplegia as a predictor of accommodative component of esotropia. In: Lenerstrand G, editor. Update on strabismus and pediatric ophthalmology: Proceedings of joint ISA and AAPO&S meeting. Vancouver, Canada. Jun 19 to 23, 1994. 1st ed. Vancouver: CRC press; 1995. p. 214-6.