



Intermittent exotropia: are we undermining by not overminusing?

Article

Accepted Version

Brodsky, M. C., Horwood, A. M. and Riddell, P. M. (2015) Intermittent exotropia: are we undermining by not overminusing? *Journal of the American Association of Pediatric Ophthalmology and Strabismus*, 15 (5). pp. 397-398. ISSN 1091-8531 doi: <https://doi.org/10.1016/j.jaapos.2015.05.011> Available at <http://centaur.reading.ac.uk/55572/>

It is advisable to refer to the publisher's version if you intend to cite from the work.

To link to this article DOI: <http://dx.doi.org/10.1016/j.jaapos.2015.05.011>

Publisher: Elsevier

All outputs in CentAUR are protected by Intellectual Property Rights law, including copyright law. Copyright and IPR is retained by the creators or other copyright holders. Terms and conditions for use of this material are defined in the [End User Agreement](#).

www.reading.ac.uk/centaur

CentAUR

Central Archive at the University of Reading

Reading's research outputs online

Invited Commentary

Intermittent exotropia: are we underminusing by not overminusing?

Michael C. Brodsky, MD,^a Anna M. Horwood, PhD,^b Patricia M. Riddell, DPhil^c

Author affiliations: ^aDepartment of Ophthalmology and Neurology, Mayo Clinic, Rochester, Minnesota; ^bInfant Vision Laboratory, School of Psychology and Clinical Language Sciences, University of Reading, United Kingdom; ^cOrthoptic Department, Royal Berkshire Hospital, Reading, United Kingdom

Correspondence: Michael C. Brodsky, M.D., Mayo Clinic, 200 First St SW, Rochester, MN 55905 (email: Brodsky.Michael@mayo.edu).

Supported in part by a grant from the Knights Templar Eye Foundation, Research to Prevent Blindness, New York, NY, a UK Department of Health Research Capacity Development award PDA 01/05/031, a UK Medical Research Council Clinician Scientist Award G0802809, and Mayo Foundation, Rochester, Minnesota.

Word count: 969

Intermittent exotropia may be the most treatable yet the most incurable form of strabismus.¹ The optimal timing of any surgical treatment has been vigorously debated. One study found that up to 86% of “successfully” treated patients require repeat strabismus surgery for recurrent exodeviations within 15 years of initial surgery.² Many patients are therefore treated conservatively with observation, part-time occlusion of one or both eyes, or over-minus lenses to force accommodative convergence to augment esotonus and thereby control the deviation during periods of fixation.^{3,4}

Numerous studies have documented moderate success with over-minus therapy,⁴⁻⁸ but many practitioners report anecdotally that the intermittent exotropia reverts back to its previous level of control once this therapy is discontinued. Despite the fact that children have ample accommodative reserve, some ophthalmologists instinctively dislike inflicting unnecessary accommodative demands on children with negligible baseline refractive errors. Recent reports of myopia in children with intermittent exotropia have further dampened enthusiasm for this treatment,⁹ despite the fact that several studies have found that over-minusing has no detectable effect on myopic progression.^{7,10}

Recent experimental studies suggest that targeting accommodation may play a pivotal role in controlling intermittent exotropia, albeit not the one that is classically understood. Horwood and colleagues have proposed that the therapeutic use of “over-minus” lenses in intermittent exotropia could *eliminate* blur and promote *fusional* convergence rather than *induce* blur and stimulate *accommodative* convergence, as is commonly held.¹¹ These investigators used a remote haploscopic video refractor to separately manipulate blur, disparity, and proximal “looming” cues while simultaneously monitoring accommodation and vergence angles.¹¹⁻¹³ They found that disparity cues provide the primary drive for both convergence and accommodation in

normal subjects¹² and in subjects with intermittent exotropia.¹¹ Furthermore, patients with intermittent exotropia under-accommodate in the exotropic state and over-accommodate in the orthophoric state.¹¹ Patients with intermittent exotropia seem to use disparity-induced vergence cues to restore binocular alignment, with greater convergence stress demand during near fixation triggering over-accommodation, and possibly promoting the development of myopia over time.¹¹ Other investigators have used different methodologies to draw similar conclusions regarding the primary role of disparity-induced vergence in controlling intermittent exodeviations.¹⁴⁻¹⁶ This fusional mechanism bears similarities to that in infantile nystagmus, wherein it is advised that any hyperopia be maximally corrected because it is only fusional convergence that damps the distance nystagmus.¹⁷

One implication of this “inverted” sensorimotor control mechanism is that the therapeutic use of over-minus lenses in intermittent exotropia could actually serve to *eliminate blur* that is secondary to the excess accommodation resulting from disparity-driven convergence and thereby *promote fusional convergence* at near. This mechanism is radically different from the accepted rationale for treating intermittent exotropia with over-minus lenses, which is to increase blur and force accommodative convergence to focus the visual image. Whether both mechanisms are operative in the same or in different patients remains to be determined. It may be that stronger minus lenses (-2 D to -4 D) favor accommodative convergence in children who are equipped to meet additional accommodative demands, whereas weaker minus lenses (-1 D to -2 D) favor fusional convergence in children that are not.

Both convergence and accommodation are normally necessary for near vision but neither are necessary for distance vision. Yet even in individuals with normal vision, disparity drives convergence and it also drives accommodation (rather than vice versa).¹¹ However, patients with

intermittent exotropia need to converge at every distance, which drags along accommodation at those distances. So patients with intermittent exotropia at distance are in a dilemma—they can either converge to fuse but get blurred distance vision or allow divergence in the distance to leave things clear with relaxed accommodation. Because stereopsis is less important for distance, they are more likely to opt for the clear vision strabismus option (and panoramic vision, which some appear to prefer). Minus lenses therefore allow them to converge to control the exodeviation by correcting the over-accommodation so they can have both binocular vision *and* clear vision. On this basis, patients with intermittent exotropia may close one eye in part to eliminate the need for fusional convergence, enabling them to relax accommodation to the appropriate level for the distance. For near fixation, most normal individuals have an accommodative lag of at least half a diopter. In intermittent exotropia, the small lead produced by over-convergence may generate a degree of over-accommodation that similarly falls within the depth of focus or tolerable blur that everyone seems to accept.

If over-accommodation is indeed operative during periods of binocular alignment, one would expect several corollary clinical findings. First, one would expect patients with intermittent exotropia to experience diminished vision under binocular conditions. This symptom was recognized in 1945 by Burian,¹⁸ and elaborated on in 1966 by Seaber.¹⁹ A prospective study by Walsh and colleagues²⁰ documented decreased binocular vision and distance stereopsis in many patients with intermittent exotropia. Thus, although affected patients rarely complain of this symptom, careful examination shows that over-accommodation negatively affects vision during periods of binocular alignment. Second, one would also expect moderately hyperopic patients with intermittent exotropia to control their exodeviation better when given their full cycloplegic refractions. A study by Iacobucci and colleagues²¹ found that

these patients often regain good control when given their full cycloplegic refraction, suggesting that fusional convergence is more powerful than accommodative convergence in controlling the deviation. Finally, we would expect that low to moderate levels of over-minusing would not induce a long-term myopic shift in patients with intermittent exotropia, an outcome that has been confirmed in several studies.^{7,21} Furthermore, a recent 6-year-long prospective study found no change in myopic shift in children aged 7-12 years who underwent successful bilateral lateral rectus muscle recession.²²

The therapeutic implication of these findings is that some patients with poorly controlled intermittent exotropia may be rescued from strabismus surgery by small amounts of over-minus treatment to clear up vision and fortify binocular alignment. We may discover that we have been inadvertently under-minusing our patients with intermittent exotropia by not over-minusing them.

References

1. Holmes JM, Hatt SR, Leske DA. Is intermittent exotropia a curable condition? *Eye* 2015;29:171-6.
2. Ekdawi NS, Nusz KJ, Diehl NN, Mohny BG. Postoperative outcomes in children with intermittent exotropia in a population-based cohort. *J AAPOS* 2009;13:4-7.
3. Piano M, O'Connor A. Conservative management of intermittent exotropia: a review. *Am Orthop J* 2011;61:103-16.
4. Kennedy J. The correction of divergent strabismus with concave lenses. *Am J Optom Arch Am Acad Optom* 1954;31:605-14.
5. Caltrider N, Jampolsky A: Overcorrecting minus lens therapy for treatment of intermittent exotropia. *Ophthalmology* 1983;90:1160-65.
6. Coffey B, Wick B, Cotter S, Scharre J, Horner D. Treatment options in intermittent exotropia: a critical appraisal. *Optom Vis Sci* 1992;69:386-404.
7. Rowe FJ, Noonan CP, Freeman G, DeBeil J. Intervention for intermittent distance exotropia with overcorrecting minus lenses. *Eye* 2009;23:320-25.
8. Rutstein RP, Marsh-Tootle W, London R. Changes in refractive error for exotropes treated with overminus lenses. *Optom Vis Sci* 1989;66:487-91.
9. Ekdawi NS, Nusz KJ, Diehl NN, Mohny BG. The development of myopia among children with intermittent exotropia. *Am J Ophthalmol* 2010;149:503-7.
10. Kushner BJ. Does overcorrecting minus lens therapy for intermittent exotropia cause myopia? *Arch Ophthalmol* 1999;117:638-42.
11. Horwood AM, Riddell PM. Evidence that convergence rather than accommodation controls intermittent distance exotropia. *Acta Ophthalmol* 2012;90:e109-17.

12. Horwood AM, and Riddell PM: The use of cues to convergence and accommodation in naïve, uninstructed participants. *Vision Res* 2008;48:1613-1624.
13. Horwood AM, Riddell PM. Accommodation and vergence response gains to different near cues characterize specific esotropias. *Strabismus* 2013;21:155-64.
14. Ahn SJ, Yang HK, Hwang J-M. Binocular visual acuity in intermittent exotropia: role of accommodative convergence. *Am J Ophthalmol* 2012;154:981-6.
15. Laird PW, Hatt SR, Leske DA, Holmes JM. Distance stereoacuity in prism-induced convergence stress. *J AAPOS* 2008;12:370-74.
16. Laird PW, Hatt SR, Leske DA, Holmes JM. Stereoacuity and binocular visual acuity in prism-induced exodeviation. *J AAPOS* 2007;11:362-6.
17. Reinecke RD. Idiopathic infantile nystagmus: Diagnosis and treatment. *J AAPOS* 1997;1:67-82.
18. Burian HM: Intermittent (facultative) divergent strabismus. Its influence on visual acuity and the binocular act. *Am J Ophthalmol* 1945;28:525-527.
19. Seaber JH: Pseudomyopia in exodeviations. *Am Orthop J* 1967;1966;16:67-72.
20. Walsh LA, LaRoche GR, Tremblay F. The use of binocular acuity in the assessment of intermittent exotropia. *J AAPOS* 2000;4:154-7.
21. Iacobucci IL, Archer SM, Giles CL. Children with exotropia responsive to spectacle correction of hyperopia. *Am J Ophthalmol* 1993;116:79-83.
22. Shin KH, Hyun SH, Kim IN, Paik HJ. The impact of intermittent exotropia and surgery for intermittent exotropia on myopic progression among early school-aged children with myopia. *Brit J Ophthalmol* 2014;98:1250-54.