Electronic publication,
Published on December 20th, 2025.
https://doi.org/10.33700/jhrs.4.2.159
eISSN: 2820-5480

Alma Mater Europaea University – ECM
Journal of Health and Rehabilitation Sciences, 2025 Dec 20; 4(2), 11-19
Health Research

Evaluation of horizontal fusional vergence in young children with intermittent exotropia using the synoptophore and prism bar

Rajesh KUMAR[1],
Malhar VYAS[2],
Neebha PASSI[3],
[1]Department of Optometry, Nims College of Allied & Health care Sciences, NIMS University Rajasthan, Jaipur, Rajasthan, 303121 India
[2]Department of Ophthalmology, Nims University Rajasthan, Jaipur, Rajasthan, 303121 India
[3]Regional Institute of Ophthalmology, Pt. B. D. Sharma Post Graduate Institute of Medical Sciences, Rohtak, Haryana 124001 India
Email: rajeshmlgh8@gmail.com

Received: 09-Aug-2025
Revised: 03-Oct-2025
Accepted: 11-Oct-2025
Online first: 13-Oct-2025

Original Article

Abstract

Purpose: The aim of the study was to compare the synoptophore and prism bar for assessing horizontal fusional vergence (HFV) in young children with intermittent exotropia (IXT).

Methods: The research involved 98 subjects with IXT, aged between 6 and 16 years. The examination included vision assessment, a cover test, identification of the dominant eye, and measurement of the angle of deviation using a prism bar. The subjects' HFV (positive and negative fusional vergence) was assessed using a horizontal prism bar and synoptophore at both near and far distances.

Results: The positive fusional vergence (PFV) break points of the synoptophore are above those of the prism bar at both near and distance ranges ($P < 0.01$). There was a statistically significant difference in PFV recovery points for both near ($P < 0.01$) and distance ($P < 0.01$). There were no statistically significant changes in the near-negative fusional vergence (NFV) blur and break points as determined by the prism bar and synoptophore. The distance, NFV blur, and break points were larger on the synoptophore compared to the prism bar ($P < 0.01$). The difference in NFV recovery points was statistically significant at both near ($P = 0.05$) and distance ($P = 0.03$).

Conclusion: It is essential to exercise caution when assessing the PFV and NFV in young children with IXT, as the synoptophore and prism bar are not comparable.

Keywords: Intermittent exotropia, Horizontal Fusional vergence, synoptophore, prism bar, office control score, step vergence method

Citation: Kumar, R., Vyas, M., Passi, N. (2025). Evaluation of horizontal fusional vergence in young children with intermittent exotropia using the synoptophore and prism bar. *Journal of Health and Rehabilitation Sciences*, 2025 Dec 20; 4(2), 11–19. https://doi.org/10.33700/jhrs.4.2.159

Corresponding address:
Rajesh KUMAR
[1]Department of Optometry, Nims College of Allied & Health care Sciences, NIMS University Rajasthan, Jaipur, Rajasthan, 303121 India
Email: rajeshmlgh8@gmail.com

1. Introduction

Intermittent exotropia (IXT) represents the most typical form of strabismus found in young children. (Juge et al. 2010, Wang et al. 2021, Gore et. al. 2023) Some patients with IXT exhibit a progressive increase in exodeviation, while others maintain a stable condition or demonstrate symptoms of improvement. (Heydarian et. al. 2020, Grounlund 2006) The evaluation of horizontal fusional vergence (HFV) is critical to the standard examination, as it reflects the patient's binocular vision status and, when combined with other orthoptic assessments, contributes to the diagnosis of binocular vision disorders. (Rovira et al.2023) Fusional vergence is crucial to IXT because it measures a patient's ability to maintain binocular vision and manage deviations from it, aiding diagnosis, tracking progression, and planning therapy. Measurement variability may lead to inconsistent clinical judgments, emphasising the need for reliable evaluation techniques. The synoptophore and prism bar are preferred instruments for measuring fusional vergence in a clinical setting. (Plaumann et al. 2023 & Kumar et al 2024 and 2025) The assessment of HFV (positive and negative fusional vergence) is a critical component in evaluating binocular single vision in IXT. Few studies have compared the two approaches. (Fu et al. 2015) measured HFV in 8–15-year-olds with IXT and orthophoria subjects and then compared them. In IXT children (Fu et al., 2015), the synoptophore recorded much higher positive fusional vergence (PFV) compared to the prism bar, while the prism bar showed greater negative fusional vergence (NFV) than the synoptophore. However, this study did not conduct a comparison of the HFV results acquired through the synoptophore and prism bar. Haque et al. (2024) conducted a study comparing two methods among orthophoria subjects aged 18–23 years, revealing that the synoptophore recorded significantly greater PFV break points compared to the prism bar. The NFV and PFV blur and recovery points were also higher on the synoptophore than the prism bar, but the differences were not statistically significant. Alrasheed et al. (2022) discovered a notable shift in PFV and NFV when using the prism bar and synoptophore. We evaluated the near (33 cm) and distant (6 m) PFV and NFV, comparing the outcomes acquired through the synoptophore and prism bar in children diagnosed with IXT. This study addresses a gap in literature by directly comparing PFV and NFV measurements obtained through both the synoptophore and prism bar in children with intermittent exotropia at near and distance. This comparison contributes to existing knowledge and may inform more standardised clinical evaluation practices.

2. Materials and methods

The Biomedical Research Ethics Committee (Registration Number: EC/NEW/INST/2022/HR/0189; Letter Number: BREC/23/448) reviewed and approved the study at the Regional Institute of Ophthalmology (RIO). The research was conducted in accordance with the principles outlined in the Declaration of Helsinki. The investigation included ninety-eight IXT subjects, ranging in age from six to sixteen years, who attended the RIO between November 2023 and October 2024. The study was designed to be a comparative cross-sectional study. We secured the necessary written informed consent before enrolling subjects. Convergence-insufficiency-type exotropia, any history of ocular surgery, nystagmus, amblyopia, anisometropia, and any non-surgical treatment were excluded from the study. OCS: IXT at near (control grades zero, one, and two) and distance (control ≥ grade one), visual acuity 6/6 in each eye, were included in the study.

Each subject underwent a comprehensive orthoptic evaluation, which included tests of their best-corrected visual acuity, near point of convergence motility, and anterior segment examination. The examiner determined the dominant eye by instructing the subjects to align their finger with a distant, isolated 6/12 optotype while keeping both eyes open. The examiner then covered the eyes in alternation to determine which eye would align with the 6/12 optotype (i.e., the dominant eye).

All subjects underwent measurement of their PFV and NFV by applying a prism bar and synoptophore. The same examiner performed all measurements in a room with constant illumination. The blur point was determined as the break point if neither test demonstrated blur.

2.1 Material used for assessing Thought, Language, and Communication in Tamil-speaking Persons with Aphasia

Sample size formula:

$$n=\frac{\left(z_{\propto\sum}+z_{1-\beta}\right)^2 * p *(1-\mathrm{p})}{d^2}=\frac{(1.96+0.84)^2 * 0.0324 *(1-0.0324)}{0.05^2}= 98.3 \cong 98$$

The data set includes the following:

$z_{\propto\sum}$ = 1.96 probability of normal distribution at 95% confidence interval,

$z_{1-\beta}$ = 0.84 Inverse probability of normal distribution at 80% confidence interval,

P = 0.0324 (3.24% prevalence), d=0.05 (5% margin of error) considered.

According to prior research, the estimated prevalence rate of IXT in children is 3.24%, or the proportion of the population believed to have the disorder. (Pan et al.2016) A key factor in determining sample size is prevalence, which indicates the probability of detecting the condition in the chosen sample.

2.2 Prism bar assessment

The horizontal prism bar assessed the PFV and NFV by using the step vergence method. The prism bar was placed above the dominant eye, It consists of a distant target with a single vertical column of 6/9 optotypes and a nearby target at a distance of 33 cm. The prism bar was employed in stages 1, 2, and 4 through 20 with an increase of 2 prism diopters (PD), and in steps 25 to 40 with a progression of 5 PD. The NFV distance was measured initially. The subjects were prompted to verify that the target remained "single and clear" at each prism level as the prism's magnitude increased at a rate of approximately 2 PD/second.

A "blur" point was recorded by the examiner in the fixation target report blur. The "break" point refers to the moment when the patient could no longer maintain single vision. The prism was systematically reduced by one step, approximately 2 PD seconds at a time, until the patient indicated that single vision had been achieved; the recorded value of the prism represented the “recovery” point. Once the patient successfully fused the largest prism, 40 PD, we applied another prism bar to the other eye.

2.3 Synoptophore assessment

The synoptophore method of measuring HFV involves the use of fusion slides (bears slides), which are two incomplete but similar images. If there was fusion, the patient could see a single, complete image (a big bear with two small bears).

The synoptophore scale in prism diopters should be used to mark the blur, break, and recovery points. Spread the synoptophore arms progressively, starting with NFV. The task is simple: “let me know when the image becomes blurry or appears to have two bears but try to keep the entire image clear for as long as possible”.When the image started to blur, we recorded the “blur” point. We recorded the "break" point when the big bear doubled, resulting in the presence of a single small bear. After completing the image, we shifted the handle backward until we recorded the "recovery" point. After a ten-second break, we measured the PFV. When measuring PFV, the synoptophore's arms turn inward to record blur, break, and recovery points (Kumar et al., 2025). When measuring near HFV, we added add a -3.0-diopter spherical lens to the synoptophore's eyepieces.

The HFV was first evaluated using a prism bar, followed by an assessment with a synoptophore. The assessment interval for PFV and NFV was approximately ten seconds, conducted between the prism bar and synoptophore.

Conversely, the duration for evaluating HFV between the prism bar and synoptophore was about 30 minutes, allowing sufficient time for fusion restoration.

We evaluated IXT's control using the Office Control Score (OCS). The office control score ranges from zero to five. It measured 5 meters and 33 centimeters. The score ranges from zero to two (phoria) and from three to five (constant tropia).

A control score of three was assigned to the 30 seconds preceding dissociation when exotropia was observed. The duration to achieve motor fusion after separation was used to provide a control score of zero to two in the absence of apparent exotropia.

2.4 Statistical analysis

Quantitative data were expressed as means and standard deviations; categorical variables were expressed as proportions and percentages. A t-test was employed to compare the prism bar and synoptophore method.

The significance level was set at 5%, with significance determined by a p-value of less than 0.05.

All statistical analyses were conducted utilising the Statistical Package for the Social Sciences (SPSS version 26) and Microsoft Excel software.

3. Results

A total of ninety-eight IXT child subjects, aged six to sixteen years, with a mean age of 11.8 ± 3 years, fulfilled the inclusion criteria for the study. There were 50 males (51%) and 48 females (49%), with a mean age of 11.8 ± 3 years (range: 6-16 years).

3.1 PFV blur and break point

The blur point of PFV at “near” was greater on the synoptophore compared to the prism bar. The blur point of distance was also greater on the synoptophore compared to the prism bar, as shown in Table 1.

For measuring PFV with the prism bar, 18 subjects (19%) at near and 21 (22%) subjects at distance did not report experiencing blur.

For measuring PFV with the synoptophore, 26 subjects (27%) at near and 20 subjects (21%) at distance did not report experiencing blur.

Table 1: Comparison of near and distance PFV and NFV using an unpaired t-test

Variables			Prism Bar (PD)	Synoptophore (PD)	t-test	P – Value
PFV	Near	Blur	12.6 ± 9.1	18.3 ± 11.4	-3.87	<0.01
		Break	15.7 ± 11.3	21.8 ± 12.9	-3.52	<0.01
		Recovery	9.7 ± 8.4	14.5 ± 12.9	-3.27	<0.01
	Distance	Blur	8.2 ± 6.3	13.7 ± 9.7	-4.71	< 0.01
		Break	10.4 ± 7.4	17.1 ± 11	-5.0	< 0.01
		Recovery	5.5 ± 5.6	9.4 ± 9.3	-3.56	<0.01
NFV	Near	Blur	13.2 ± 6.6	13.4 ± 7.2	-0.20	0.84
		Break	16.6 ± 7.8	16.3 ± 7.7	0.27	0.79
		Recovery	10.9 ± 7	8.8 ± 7.7	2.0	0.05
	Distance	Blur	9.9 ± 5.5	13.6± 6.8	-4.19	< 0.01
		Break	12.5 ± 7	16.5 ± 7.6	-3.84	<0.01
		Recovery	7.3 ± 5.5	9.2 ± 6.3	-2.25	0.03

***Abbreviations**: PFV, positive fusional vergence; NFV, Negative fusional vergence; PD, Prism diopter;*

3.2 PFV recovery point

The average near PFV recovery point was considerably higher on the synoptophore than on the prism bar. Likewise, the distance from the PFV recovery point was also larger in comparison to the prism bar.

The disparity in recovery points was statistically significant at both near and distant ($p < 0.01$), as shown in Table 1.

3.3 NFV blur and break point

There was no statistically significant difference between the synoptophore and prism bars in terms of the mean near-NFV blur point.

The distance measuring the NFV blur point on the synoptophore was greater than the distance measured with the prism bar, indicating a statistically significant difference ($p < 0.01$).

Twenty-two subjects (23%) at long distance and seventeen subjects (18%) at near distance indicated no blur during the prism bar NFV assessment.

Twenty subjects (21%) at near and twenty-six subjects (27%) at distance reported no blur when evaluating NFV with the synoptophore.

The average near NFV break point measured on the synoptophore and the prism bar did not differ significantly ($p = 0.79$).

In contrast, the distance NFV break point was significantly higher on the synoptophore compared with the prism bar ($p < 0.01$).

3.4 NFV recovery point

The mean near NFV recovery point was greater on the prism bar compared to the synoptophore, but the distant NFV recovery point was greater on the synoptophore relative to the prism bar.

A statistically significant difference in recovery points was observed between the two distances ($p = 0.03$) and near ($p = 0.05$).

Tables 2 and 3 present a summary of relevant near- and distant HFV research data. All parameters are expressed in prism diopter (PD) units.

Table 2: Summary of near PFV and NFV data among various research studies

Variables			Intermittent Exotropia												Exophoria	
			Current Study		Fu et al.		Sharma et al.		Yam et al.		Hatt et al.		Ma et al.		Alrasheed et al.	
			PFV	NFV	PFV	NFV	PFV	NFV	PFV	NFV	PFV	NFV	PFV	NFV	PFV	NFV
Near	Synoptophore	Bl.	18.3± 11.4	13.4 ± 7.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Br.	21.8± 12.9	16.3 ± 7.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	24.7	12.7
		Rc.	14.5± 12.9	8.8± 7.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Prism bar	Bl.	12.6± 9.1	13.2 ± 6.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Br.	15.7± 11.3	16.6 ± 7.8	18.2± 1.6	24.7± 1.3	24.1 ± 5.5	9.4± 1.7	17.8± 11.1	NA	21± 14	NA	21.6± 16.1	23.6± 11.6	22.6	13.9
		Rc.	9.7± 8.4	10.9 ± 7	10.1	18.4	17.9± 2.5	6.5± 1.5	13.1± 9.7	NA	11± 10	NA	15.8± 14.9	17.8± 9.5	NA	NA

Abbreviations: *Bl, Blur; Br, Break; Rc, Recovery; NA, Not applicable*

Table 3: Summary of distance PFV and NFV data among various research studies

			Intermittent Exotropia												***Orthophoria***	
Variables			*Current Study*		*Fu et al.*		*Sharma et al.*		*Yam et al.*		*Hatt et al.*		*Ma et al.*		*Haque et al.*	
			PFV	*NFV*	*PFV*	*NFV*	*PFV*	*NFV*	*PFV*	*NFV*	*PFV*	*NFV*	*PFV*	*NFV*	*PFV*	*NFV*
Distance	*Synoptophore*	*Bl.*	*13.7 ± 9.7*	*13.6±6.8*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*13.73±1.52*	*8.05± 0.77*
		Br.	*17.1 ±11*	*16.5 ± 7.6*	*22.7±2.15*	*8.98±1.9*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*30.9±3.8*	*8.5± 0.8*
		Rc.	*9.4 ±9.3*	*9.2 ±6.3*	*14.2± 1.8*	*5.6± 0.8*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*20.2*	*5.5± 0.64*
	Prism bar	*Bl.*	*8.2 ±6.3*	*9.9 ±5.5*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*11.8±0.89*	*6.7± 0.4*
		Br.	*10.4 ± 7.4*	*12.5 ±7*	*18.7± 1.5*	*18.8±1*	*18.0± 3.3*	*6.5± 1.6*	*7.9± 7.5*	*NA*	*7± 8*	*NA*	*7.2± 11.0*	*7.7± 10.3*	*18.1±1.27*	*7.2± 0.37*
		Rc.	*5.5± 5.6*	*7.3± 5.5*	*11*	*14*	*14.6± 2.5*	*4.3± 1.5*	*5.0± 6.1*	*NA*	*2± 5*	*NA*	*5.4± 8.3*	*6.0± 8.4*	*14.1±1.2*	*4.7± 0.38*

Abbreviations: *Bl, Blur; Br, Break; RC, Recovery;*

4. Discussion

This study presents a comparison of the PFV and NFV measurements obtained through the synoptophore and prism bar in young children diagnosed with IXT.

The mean PFV had been significantly higher when measured with a synoptophore compared to a prism bar, both at a distance of 6m and near at 33cm. Upon evaluation using both methods, no statistically significant differences were observed between the blur and the break at the near NFV. The prism bar showed more differences in recovery points when compared to the synoptophore. When compared to the prism bar, the synoptophore showed statistically significant variations in the NFV at a distance.

Several studies have investigated the HFV in IXT. However, there are limited studies that measure the PFV and NFV in children with IXT using the synoptophore and prism bar together. Fu et al. used the prism bar and synoptophore to measure the PFV and NFV in children with IXT, who exhibited significantly reduced PFV compared to normal children, both at near and distance. When using a prism bar to measure, the mean NFV was notably higher in children with IXT compared to normal children. This study compared the measured HFV of normal children to that of IXT children, but it did not compare the measured PFV and NFV of the synoptophore and the prism bar. A recent study by Haque et al. indicated that the distortion, break, and recovery points of the synoptophore's PFV and NFV were larger than those observed with the horizontal prism bar. The average difference was 12.08 prism diopters. Only the PFV and NFV (blur, break, and recovery points) were reported by the authors at a distance of six meters in young patients diagnosed with orthophoria or heterophoria. Conversely, our study employed the synoptophore and step vergence method to assess PFV and NFV in children with IXT at both near (33 cm) and distant (6 m), obtaining comparable results.

Alrasheed et al. also reported the PFV and NFV in exophoric young patients by the synoptophore and prism bar and found that the synoptophore provided a higher range of PFV and NFV than the prism bar. The authors only reported the breakpoint of PFV and NFV at a distance of 33 cm and did not report the value at a distance of six meters. In our study, we evaluated the PFV and NFV (blur, break, and recovery points) at both 33cm and six-meter distances and determined that the near PFV was greater on the synoptophore compared to the prism bar. The measurement indicated that NFV did not reveal any statistically significant difference between the synoptophore and the prism bar.

Antona et al. assessed the horizontal PFV and NFV in young patients using a prism bar and a rotary prism and found that the PFV was higher when compared to the prism bar at a distance. They recommended that both methods should not be used interchangeably in clinical practice. (Antona et al. 2008 & Goss et al.2011). The repeatability of evaluating fusional vergence with a prism bar varies in subjects with IXT. The patients exhibit diminished ability to converge at a distance, although their other vergence characteristics remain unchanged. (Ma et al. 2022) Hatt et al. (2011) reported that the NFV was greater in children with IXT. According to another research, the severity of IXT in many subjects was not properly represented by the control evaluation at a particular point in time. (Hatt et al. 2008). Few previous studies have examined the PFV and NFV in children suffering from IXT. Sharma et al. analysed preoperative and postoperative NFV and PFV in 31 adults and children with IXT. He discovered that the fusional vergence of IXT patients was deficient. The study's sample size of children remains unclear. (Sharma et al. 2008) Yam et al. (2013) stated that NFV is similar among different levels of control in children with IXT. Liebermann et al. (2012) compared 32 children with IXT with 38 normal non-strabismic children for measured fusional divergence and found that most of the children have normal near NFV, but half have reduced distance NFV. The observed differences between synoptophore and prism bar measurements may be attributed to variations in testing methodology and dissociation levels. The synoptophore provides a controlled and dissociative testing environment featuring central fusion targets, which may result in elevated PFV and NFV values. The prism bar employs more naturalistic, peripheral fusion stimuli and accommodates variable patient responses, potentially leading to reduced vergence measurements.

4.1 Limitations of this study

Firstly, the subjects did not report the blur point, which we consider to be the break point in our analysis. These may have affected our statistical analysis. Second, we did not employ a one-hour occlusion patch to measure the angle of deviation. Third, measuring HFV in a synoptophore and prism bar is a time-consuming process that requires good cooperation from the children; therefore, it could vary depending on the examiner's skills.

4.2 Future Directions

In children with IXT, longitudinal studies of PFV and NFV may reveal the natural history of vergence function and its role in disease progression. Objective measurement methods, such as eye-tracking systems and automated synoptophore devices, can reduce examiner bias and improve reproducibility.

5. Conclusion

The PFV and NFV assessed using the synoptophore are greater than those measured by the prism bar in children with IXT. It is essential to exercise caution when evaluating the PFV and NFV in young children with IXT, as the synoptophore and prism bar are not comparable in these situations. Since the two methods are not interchangeable, clinicians should interpret results with caution and consistently use the same method for diagnosis, monitoring, and treatment planning. The higher values obtained from the synoptophore might result in an overestimation of fusional reserves when compared directly to prism bar results, potentially influencing management decisions such as the timing of surgery or the initiation of vision therapy.

Conflict of interests

The authors declare no conflicts of interest.

6. References

Alrasheed, S. H., & Aldakhil, S. (2022). Comparison of measured fusional vergence amplitudes using prism bar and synoptophore in Sudanese patients with near exophoria. Open Ophthalmology Journal, 16, e187436412209301. https://doi.org/10.2174/18743641-v16-e2209301

Antona, B., Barrio, A., Barra, F., Gonzalez, E., & Sanchez, I. (2008). Repeatability and agreement in the measurement of horizontal fusional vergences. Ophthalmic and Physiological Optics, 28(5), 475–491. https://doi.org/10.1111/j.1475-1313.2008.00583.x

Fu, T., Wang, J., Levin, M., Su, Q., Li, D., & Li, J. (2015). Fusional vergence detected by prism bar and synoptophore in Chinese childhood intermittent exotropia. Journal of Ophthalmology, 2015, 1–6. https://doi.org/10.1155/2015/987048

Gore, J., Rath, S., & Ganesh, S. (2023). Clinical profile of childhood exotropia in a tertiary eye care center in North India. Indian Journal of Ophthalmology, 71(12), 3637–3641. https://doi.org/10.4103/IJO.IJO_29_23

Goss, D. A., & Becker, E. (2011). Comparison of near fusional vergence ranges with rotary prisms and with prism bars. Optometry, 82(2), 104–107. https://doi.org/10.1016/j.optm.2010.09.011

Grönlund, M. A., Andersson, S., Aring, E., Hård, A. L., & Hellström, A. (2006). Ophthalmological findings in a sample of Swedish children aged 4–15 years. Acta Ophthalmologica Scandinavica, 84(2), 169–176. https://doi.org/10.1111/j.1600-0420.2005.00615.x

Haque, S., Toor, S., & Buckley, D. (2024). Are horizontal fusional vergences comparable when measured using a prism bar and synoptophore? British and Irish Orthoptic Journal, 20, 85–93. https://doi.org/10.22599/bioj.326

Hatt, S. R., Leske, D. A., Mohney, B. G., Brodsky, M. C., & Holmes, J. M. (2011). Fusional convergence in childhood intermittent exotropia. American Journal of Ophthalmology, 152(2), 314–319. https://doi.org/10.1016/j.ajo.2011.01.042

Hatt, S. R., Mohney, B. G., Leske, D. A., & Holmes, J. M. (2008). Variability of control in intermittent exotropia. Ophthalmology, 115(2), 371–376.e2. https://doi.org/10.1016/j.ophtha.2007.03.084

Heydarian, S., Hashemi, H., Jafarzadehpour, E., Ostadi, A., Yekta, A., & Aghamirsalim, M., et al. (2020). Non-surgical management options of intermittent exotropia: A literature review. Journal of Current Ophthalmology, 32(3), 217–225. https://doi.org/10.4103/JOCO.JOCO_81_20

Jung, J. W., & Lee, S. Y. (2010). A comparison of the clinical characteristics of intermittent exotropia in children and adults. Korean Journal of Ophthalmology, 24(2), 96–100. https://doi.org/10.3341/kjo.2010.24.2.96

Kumar, R., Passi, N., Mishra, S. K., & Prajapat, M. K. (2025). Synoptophore in binocular vision anomalies: A short review. Journal of Clinical Ophthalmology and Research, 13(2), 214–219. https://doi.org/10.4103/jcor.jcor_211_24

Kumar, R., & Phogat, D. J. (2024). Vision therapy for amblyopia with intermittent exotropia: A case report. International Journal of Ophthalmology and Optometry, 6(2), 1–6. https://doi.org/10.33545/26648547.2024.v6.i1a.31

Liebermann, L., Hatt, S. R., Leske, D. A., Yamada, T., Mohney, B. G., Brodsky, M. C., et al. (2012). Assessing divergence in children with intermittent exotropia. Strabismus, 20(1), 11–16. https://doi.org/10.3109/09273972.2012.655838

Ma, M. M., Kang, Y., Scheiman, M., Chen, Q., Ye, X., & Chen, X. (2022). Reliability of the step vergence method for assessing fusional vergence in intermittent exotropia. Ophthalmic and Physiological Optics, 42(4), 913–920. https://doi.org/10.1111/opo.12972

Pan, C. W., Zhu, H., Yu, J. J., Ding, H., Bai, J., Chen, J., et al. (2016). Epidemiology of intermittent exotropia in preschool children in China. Optometry and Vision Science, 93(1), 57–62. https://doi.org/10.1097/OPX.0000000000000754

Plaumann, M. D., Roberts, K. L., Wei, W., Han, C., & Ooi, T. L. (2023). Refining clinical quantification of depth of suppression in amblyopia through synoptophore measurement. Life, 13(9), 1900. https://doi.org/10.3390/life13091900

Rovira-Gay, C., Mestre, C., Argiles, M., Vinuela-Navarro, V., & Pujol, J. (2023). Feasibility of measuring fusional vergence amplitudes objectively. PLOS ONE, 18(5), e0284552. https://doi.org/10.1371/journal.pone.0284552

Sharma, P., Saxena, R., Narvekar, M., Gadia, R., & Menon, V. (2008). Evaluation of distance and near stereoacuity and fusional vergence in intermittent exotropia. Indian Journal of Ophthalmology, 56(2), 91–95. https://doi.org/10.4103/0301-4738.39116

Wang, Y., Zhao, A., Zhang, X., Huang, D., Zhu, H., Sun, Q., et al. (2021). Prevalence of strabismus among preschool children in eastern China and comparison at a 5-year interval: A population-based cross-sectional study. BMJ Open, 11(10), e055112. https://doi.org/10.1136/bmjopen-2021-055112

Yam, J. C. S., Chong, G. S. L., Wu, P. K. W., Wong, U. S. F., Chan, C. W. N., & Ko, S. T. C. (2013). A prospective study of fusional convergence parameters in Chinese patients with intermittent exotropia. Journal of AAPOS, 17(4), 347–351. https://doi.org/10.1016/j.jaapos.2013.03.023