Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

# Botulinum toxin type A injection versus bilateral lateral rectus recession for basic-type intermittent exotropia: A retrospective comparative cohort study

**Fawzia Alhaimi**

f_alhaimi@yahoo.com

King Khaled Eye Specialist Hospital and Research Center

**Lamia Alhijji**

King Khaled Eye Specialist Hospital and Research Center

**Abdulrahman Alyahya**

King Khaled Eye Specialist Hospital and Research Center

**Khalid Faiz Alshehri**

King Khaled Eye Specialist Hospital and Research Center

---

**Research Article**

**Keywords:** Intermittent exotropia, Botulinum toxin type A, Bilateral lateral rectus recession, Strabismus surgery, Exodrift, Re-intervention

**Posted Date:** September 23rd, 2026

**DOI:** https://doi.org/10.21203/rs.3.rs-10974597/v1

**License:** This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

**Additional Declarations:** No competing interests reported.

---

## Abstract

# Purpose

To compare alignment outcomes, exodrift, and re-intervention after botulinum toxin type A (BTX-A) injection versus bilateral lateral rectus (BLR) recession for basic-type intermittent exotropia (IXT).

# Methods

This retrospective comparative cohort included 343 patients with basic-type IXT treated with BTX-A (n = 134) or BLR recession (n = 209) from 2010 through 2024, with records reviewed through March 2026 and at least 12 months of follow-up. Primary outcomes were changes in distance and near deviations at final follow-up; secondary outcomes were exodrift and re-intervention. Regression adjusted for age and baseline deviation.

# Results

Mean age at intervention was 10.6 ± 6.4 years in the BTX-A group and 12.0 ± 9.4 years in the BLR group. After adjustment, BLR recession was associated with greater improvement in distance deviation (adjusted β, 16.43 prism diopters [PD]; 95% CI, 14.03–18.84) and near deviation (adjusted β, 16.12 PD; 95% CI, 13.69–18.56). Exodrift was greater after BTX-A at distance (5.3 vs 0.2 PD) and near (5.7 vs 0.6 PD; both P < .001). Re-intervention was more frequent after BTX-A (61.2% vs 23.4%; risk ratio, 2.61; 95% CI, 1.97–3.45).

# Conclusion

BLR recession was associated with greater and more durable alignment improvement and fewer re-interventions than BTX-A injection for basic-type IXT. Residual confounding cannot be excluded.

## Clinical implications

Among patients with basic-type intermittent exotropia, bilateral lateral rectus recession was associated with greater alignment correction, less exodrift, and fewer re-interventions than botulinum toxin type A injection after adjustment for age and baseline deviation. These findings support BLR recession when durable alignment is the primary treatment goal. BTX-A remains a minimally invasive option for selected patients, but families should be counseled about the higher likelihood of retreatment. Because treatment allocation was nonrandomized and follow-up differed between groups, the findings should inform, rather than replace, individualized clinical decision-making.

## Background

Intermittent exotropia (IXT), the most common childhood-onset exotropia, alternates between periods of alignment and a manifest outward deviation, typically during visual fatigue, illness, or inattention. Its reported prevalence is 0.5%-3.5%, with higher rates in Asian populations, and onset usually occurs at 2–6 years. Although binocular single vision is initially preserved, deterioration may lead to constant exotropia, suppression, reduced stereoacuity, and psychosocial effects.1

Basic-type IXT is defined by similar distance and near deviations.2–3 This symmetric pattern is clinically relevant because treatment must address alignment at both fixation distances. Its multifactorial pathophysiology includes impaired fusional control, reduced convergence reserves, and accommodative and central neural mechanisms that affect alignment stability.1

Treatment aims to maintain binocular single vision, improve alignment, and prevent progression. Refractive correction, overminus lenses, occlusion, or orthoptic exercises may benefit selected patients, but durability is uncertain. Surgery remains standard for poor control or cosmetically significant deviation.1–2 BLR recession is commonly performed for basic-type IXT and usually provides substantial initial correction, although postoperative exodrift, recurrence, and possible reoperation remain important long-term concerns.1

BTX-A injection is a less invasive alternative to conventional strabismus surgery. It produces temporary chemodenervation by inhibiting acetylcholine release at the neuromuscular junction.4 Potential advantages include less tissue disruption, reversibility, and the option of repeat treatment. Sustained realignment may occur through adaptive changes in antagonist muscle function and binocular motor control, but outcomes are variable and its role in IXT is not established.4–5

Cochrane reviews found heterogeneous evidence for BTX-A in strabismus and a lack of high-quality comparative studies for IXT. They also emphasized the need for standardized outcome definitions, clinically meaningful measures of treatment burden, and longer follow-up.2,5

BTX-A injection and BLR recession differ in invasiveness, reversibility, durability, procedural burden, and the probability of retreatment, yet direct subtype-specific comparisons remain limited.2,5–8 We therefore compared intermediate and final alignment correction, exodrift, complications, and re-intervention after these treatments in basic-type IXT.

# Methods

This retrospective comparative cohort study included patients aged 1.9–55 years with basic-type IXT treated at a tertiary ophthalmic referral center with BTX-A injection into one or both lateral rectus muscles or BLR recession between January 1, 2010, and December 31, 2024. Records were reviewed through March 2026, and at least 12 months of follow-up was required. For patients with multiple injections, the index intervention was the most recent injection followed by at least 12 months of observation. Treatment reflected routine clinical judgment rather than random assignment and was based on deviation magnitude, age, cooperation, and surgeon judgment or preference.

IXT was classified using established clinical descriptions, with inclusion restricted to documented basic-type deviation.1,3 The study was approved by the Institutional Review Board (IRB)/Ethics Committee of King Khaled Eye Specialist Hospital & Research Center, Riyadh, Saudi Arabia (Reference No. RP-26031-IRB/0130 – 26). The study adhered to the tenets of the Declaration of Helsinki. Because of the retrospective nature of the study, the requirement for informed consent to participate was waived by the Institutional Review Board of King Khaled Eye Specialist Hospital & Research Center.

Eligible patients had basic-type IXT, best-corrected visual acuity of 20/60 or better in each eye with no more than a 2-line interocular difference, and deviation measurements at baseline, approximately 6 months, and a final visit at least 12 months after treatment. These requirements permitted longitudinal comparison of alignment and treatment durability. We excluded sensory or consecutive exotropia, restrictive or paralytic strabismus, previous strabismus surgery, follow-up of less than 12 months, incomplete records, and conditions that would make the treatment groups clinically noncomparable.

Preintervention evaluation included best-corrected visual acuity and age-appropriate refraction. Cycloplegic refraction was performed before age 10 years and autorefraction with subjective refinement thereafter. Distance and near deviation were measured by prism and alternate cover testing or, when necessary, the Krimsky test. Measurements were obtained at a minimum of two preintervention visits, and stability was defined as variation of ≤ 10 PD.1–2

BTX-A doses of 10–25 units per lateral rectus muscle were individualized to baseline deviation and administered through a temporal transconjunctival approach with a 30-gauge needle under topical or general anesthesia. Dosing and administration followed established chemodenervation principles.4–5

BLR recession was individualized to the preoperative deviation and performed under general anesthesia through a limbal or fornix conjunctival approach. The muscles were reattached using modified hang-back or direct scleral fixation.2,9

Early postoperative measurements were excluded because inflammation and peak BTX-A effect may transiently influence alignment.4–5 Outcomes were assessed at approximately 6 months and at final follow-up of at least 12 months, representing intermediate and longer-term treatment effects.

BTX-A outcomes were measured from the index injection. Injection frequency included all injections up to and including the index treatment and was categorized as a first or repeat injection for secondary analysis.

Additional BTX-A injections or strabismus surgery after the predefined final assessment were excluded from the primary treatment-effect calculation but recorded separately as re-interventions indicating treatment burden and durability.9–10

The primary outcome was change in distance and near deviation from baseline to follow-up (ΔPD = baseline deviation - follow-up deviation). Secondary outcomes were percentage correction, exodrift

between the 6-month and final assessments, complications, and re-intervention. Thus, outcomes reflected both the magnitude and persistence of alignment improvement.2,9–10

Data were analyzed with IBM SPSS Statistics 29.0 (IBM Corp., Armonk, NY). Continuous variables were compared with independent-samples t or Mann-Whitney U tests and categorical variables with chi-square or Fisher exact tests, as appropriate. Multivariable linear regression adjusted for age and baseline deviation, the prespecified principal confounders of treatment selection and response. Tests were two-sided, with $P < .05$ considered significant.

No prospective a priori sample-size calculation was performed because this was a retrospective chart review; all eligible patients during the study period were included. Effect estimates with 95% confidence intervals were emphasized to show the magnitude and precision of observed associations.

# Results

The analysis included 343 patients (134 BTX-A; 209 BLR). Mean age was 10.6 ± 6.4 versus 12.0 ± 9.4 years ($P = .297$). Baseline distance deviation was 29.6 ± 9.6 versus 36.1 ± 11.9 PD and near deviation was 30.1 ± 10.9 versus 35.6 ± 12.9 PD (both $P < .001$). Follow-up was 30.2 ± 11.4 versus 44.4 ± 28.7 months ($P < .001$); sex distribution was similar between groups. These differences indicated potential baseline and observation-time confounding (Table 1).

Table 1
Baseline characteristics of the study cohort

| Characteristic | BTX-A injection (n = 134) | BLR recession (n = 209) | P value |
|---|---|---|---|
| Age at intervention, y | 10.6 ± 6.4; 8.7 (6.6–12.5) | 12.0 ± 9.4; 9.6 (6.4–15.2) | .297 |
| Baseline distance deviation, PD | 29.6 ± 9.6; 30.0 (25.0–35.0) | 36.1 ± 11.9; 35.0 (30.0–45.0) | < .001 |
| Baseline near deviation, PD | 30.1 ± 10.9; 30.0 (25.0–38.8) | 35.6 ± 12.9; 35.0 (25.0–45.0) | < .001 |
| Distance–near difference, PD | 3.9 ± 4.7; 2.0 (0.0–5.0) | 2.9 ± 4.2; 0.0 (0.0–5.0) | .036 |
| Visual acuity, right eye, logMAR | 0.0 ± 0.1; 0.0 (0.0–0.1) | 0.1 ± 0.1; 0.0 (0.0–0.2) | < .001 |
| Visual acuity, left eye, logMAR | 0.1 ± 0.1; 0.0 (0.0–0.1) | 0.1 ± 0.1; 0.1 (0.0–0.2) | .002 |
| Final follow-up duration, mo | 30.2 ± 11.4; 28.1 (21.4–39.8) | 44.4 ± 28.7; 39.4 (21.4–62.1) | < .001 |
| Female sex, No./total No. (%) | 76/134 (56.7) | 110/209 (52.6) | .506 |

Data are presented as mean ± SD; median (IQR), unless otherwise indicated. Abbreviations: BLR, bilateral lateral rectus; BTX-A, botulinum toxin type A; IQR, interquartile range; logMAR, logarithm of the minimum angle of resolution; PD, prism diopters.

At 6 months, mean distance correction was 9.8 ± 10.9 PD after BTX-A and 24.8 ± 12.1 PD after BLR recession (difference, -15.0 PD; 95% CI, -17.5 to -12.5; P < .001). Near correction was 10.0 ± 11.3 versus 24.3 ± 12.8 PD (difference, -14.3 PD; 95% CI, -16.9 to -11.7; P < .001), and percentage correction was also greater after BLR recession for both distance and near fixation (Table 2).

Table 2
Alignment outcomes at approximately 6 months after treatment

| Outcome | BTX-A injection | BLR recession | Mean difference, BTX-A minus BLR recession (95% CI) | P value |
|---|---|---|---|---|
| Change in distance deviation, PD | 9.8 ± 10.9; 10.0 (2.2–16.8) | 24.8 ± 12.1; 25.0 (17.0–30.0) | −15.0 (− 17.5 to − 12.5) | < .001 |
| Change in near deviation, PD | 10.0 ± 11.3; 10.0 (0.0–19.0) | 24.3 ± 12.8; 25.0 (17.0–30.0) | −14.3 (− 16.9 to − 11.7) | < .001 |
| Distance correction, % | 31.7 ± 36.2; 28.6 (10.3–55.0) | 70.1 ± 27.4; 75.0 (50.0–100.0) | −38.4 (− 45.7 to − 31.2) | < .001 |
| Near correction, % | 31.9 ± 40.0; 30.0 (0.0–60.0) | 68.5 ± 31.4; 71.4 (50.0–100.0) | −36.6 (− 44.6 to − 28.5) | < .001 |

Data are presented as mean ± SD; median (IQR). A positive change in deviation indicates improvement in ocular alignment. Abbreviations: BLR, bilateral lateral rectus; BTX-A, botulinum toxin type A; IQR, interquartile range; PD, prism diopters.

At final follow-up, mean distance correction was 4.5 ± 9.6 PD after BTX-A and 24.5 ± 13.8 PD after BLR recession (difference, -20.0 PD; 95% CI, -22.5 to -17.5; P < .001). Near correction was 4.3 ± 10.9 versus 23.8 ± 14.7 PD (difference, -19.4 PD; 95% CI, -22.2 to -16.7; P < .001). Percentage correction remained greater after BLR recession (Table 3). From 6 months to final follow-up, mean exodrift was 5.3 versus 0.2 PD at distance and 5.7 versus 0.6 PD at near (both P < .001) (Table 3).

Table 3
Alignment outcomes at final follow-up

| Outcome | BTX-A injection | BLR recession | Mean difference, BTX-A minus BLR recession (95% CI) | P value |
|---|---|---|---|---|
| Change in distance deviation, PD | 4.5 ± 9.6; 5.0 (0.0–10.0) | 24.5 ± 13.8; 25.0 (15.0–31.0) | −20.0 (− 22.5 to − 17.5) | < .001 |
| Change in near deviation, PD | 4.3 ± 10.9; 5.0 (− 1.5 to 10.0) | 23.8 ± 14.7; 25.0 (15.0–35.0) | −19.4 (− 22.2 to − 16.7) | < .001 |
| Distance correction, % | 13.1 ± 32.6; 14.3 (0.0–33.3) | 68.3 ± 31.9; 73.3 (46.7–100.0) | −55.2 (− 62.3 to − 48.2) | < .001 |
| Near correction, % | 8.1 ± 47.3; 12.5 (− 8.3 to 33.3) | 66.0 ± 36.9; 75.4 (44.4–100.0) | −57.9 (− 67.4 to − 48.4) | < .001 |
| Distance exodrift from approximately 6 months to final follow-up, PD | 5.3 ± 10.4; 2.0 (0.0–10.0) | 0.2 ± 10.1; 0.0 (− 4.0 to 5.0) | 5.0 (2.8–7.3) | < .001 |
| Near exodrift from approximately 6 months to final follow-up, PD | 5.7 ± 12.1; 2.0 (0.0–11.0) | 0.6 ± 10.1; 0.0 (− 4.0 to 5.0) | 5.1 (2.6–7.6) | < .001 |

# Discussion

In this direct comparison of treatments for basic-type IXT, BLR recession was associated with greater correction, less exodrift, and fewer re-interventions than BTX-A. The consistency of unadjusted and adjusted results supports a clinically larger and more durable effect of surgery.

This pattern accords with reviews showing heterogeneous BTX-A outcomes and limited high-quality comparisons with surgery. Recent studies also emphasize recurrence, alignment stability, and retreatment rather than early alignment alone.5-8 Our study adds subtype-specific comparative data with intermediate and final measurements.

The difference was clinically meaningful: BLR recession produced about 15 PD more distance and 14 PD more near correction at 6 months, increasing to about 20 PD at final follow-up. Median distance correction at 6 months was approximately 75% after BLR recession versus 29% after BTX-A. These differences support both a greater initial surgical effect and better maintenance of correction over time.

From 6 months to final follow-up, the BTX-A group lost 5.3 PD of distance and 5.7 PD of near correction, versus 0.2 and 0.6 PD after BLR recession (both P < .001). This pattern is consistent with temporary chemodenervation after BTX-A, which weakens the lateral rectus without permanently changing its

insertion. It also accords with the recognized influence of early postoperative alignment on later stability.4-5,7-8

Adjustment for age and baseline deviation reduced, but did not eliminate, the association: BLR recession provided about 16 PD greater final correction at both distance and near. The confidence intervals excluded small effects, supporting clinical as well as statistical importance. Nevertheless, model $R^2$ values of 0.547 and 0.558 indicate that unmeasured patient-, disease-, and surgeon-level factors likely explain substantial remaining variation.

The higher re-intervention rate after BTX-A (61.2% vs 23.4%) is important for counseling about cumulative treatment burden. BTX-A avoids incisional surgery, is repeatable, and may avoid general anesthesia in selected patients, particularly young children or those with medical contraindications. However, these advantages may diminish when repeated injections are required.5-6 BLR recession provided more durable correction.

Complications were uncommon. None were documented after BTX-A; four Tenon cysts (1.9%) occurred after BLR recession and were managed according to clinical need. The between-group difference was not significant, but the small number of events precluded a meaningful comparative safety analysis.9,11

Limitations include retrospective design and nonrandom treatment allocation. Although all eligible patients were included and confidence intervals showed precision for the primary outcomes, the study was less informative for rare complications and subgroups. Baseline deviation and follow-up duration also differed between groups, and treatment allocation reflected routine clinical judgment rather than randomization.

Regression adjusted for age and baseline deviation, but residual confounding is likely. Unmeasured control, sensory status, treatment indication, patient preference, treatment indication, and surgeon decision-making could affect both selection and outcomes. Defining the index treatment as the most recent BTX-A injection followed by 12 months of observation may also select patients according to prior response and introduce additional bias.

Restriction to basic-type IXT improved internal comparability but limits generalizability to other exotropia subtypes and practice settings. Prospective comparisons with standardized measures of control, stereoacuity, exodrift, treatment success, and re-intervention are needed.

# Conclusions

BLR recession was associated with greater, more durable alignment correction and fewer re-interventions than BTX-A injection for basic-type IXT. BTX-A remains a minimally invasive option for selected patients, particularly when incisional surgery is undesirable. Prospective comparative studies are needed because residual confounding cannot be excluded.

## Abbreviations

BLR
bilateral lateral rectus
BTX-A
botulinum toxin type A
CI
confidence interval
IQR
interquartile range
IXT
intermittent exotropia
logMAR
logarithm of the minimum angle of resolution
PD
prism diopters
SD
standard deviation.

## Declarations

# Ethics approval and consent to participate

The study was approved by the Institutional Review Board (IRB)/Ethics Committee of King Khaled Eye Specialist Hospital & Research Center, Riyadh, Saudi Arabia (Reference No. RP-26031-IRB/0130 – 26). The study adhered to the tenets of the Declaration of Helsinki. Because of the retrospective nature of the study, the requirement for informed consent to participate was waived by the Institutional Review Board of King Khaled Eye Specialist Hospital & Research Center.

# Consent for publication

Not applicable.

# Competing interests

The authors declare that they have no competing interests.

# Funding

No specific funding was received for this work.

# Author Contribution

All authors contributed to data collection and preparation of the initial manuscript draft. Fawzia Alhaimi additionally contributed to data analysis and interpretation and was responsible for the final revision and preparation of the manuscript for submission. All authors reviewed and approved the final manuscript.

# Acknowledgements

Not applicable.

# Data Availability

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request, subject to institutional and ethical restrictions.

## References

1. Kaur K, Gurnani B. Intermittent exotropia. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026. Accessed July 25, 2026. https://www.ncbi.nlm.nih.gov/books/NBK574514/
2. Pang Y, Gnanaraj L, Gayleard J, Han G, Hatt SR. Interventions for intermittent exotropia. Cochrane Database Syst Rev. 2021;9:CD003737. 10.1002/14651858.CD003737.pub4.
3. Ma MM, Scheiman M. Divergence excess and basic exotropia types of intermittent exotropia: a major review. Part 1: Prevalence, classification, risk factors, natural history and clinical characteristics. Strabismus. 2023;31:97–128. 10.1080/09273972.2023.2227681.
4. Scott AB. Botulinum toxin injection of eye muscles to correct strabismus. Trans Am Ophthalmol Soc. 1981;79:734–70.
5. Bort-Martí AR, Rowe FJ, Ruiz Sifre L, Ng SM, Bort-Martí S. Ruiz Garcia V. Botulinum toxin for the treatment of strabismus. Cochrane Database Syst Rev. 2023;3:CD006499. 10.1002/14651858.CD006499.pub5.
6. Alhejaili AL, Alkayyal AA, Alawaz RA, Alshareef EK, Al-Habboubi H. Dose-effect relationship of botulinum toxin type A in the management of strabismus: a review. Cureus. 2024;16:e71271. 10.7759/cureus.71271.
7. Ren Y, Cao D, Wang Y, Jiang J, Li L. A cohort study of exodrift following the recession-plication technique for the treatment of basic type intermittent exotropia in children. Ther Adv Ophthalmol. 2026;18:25158414251413502. 10.1177/25158414251413502.

8. Srimanan W, Keokajee P. Early postoperative alignment and preoperative stereopsis as determinants of success in intermittent exotropia surgery. PLoS ONE. 2025;20:e0329609. 10.1371/journal.pone.0329609.
9. Lino P, de Aguiar PV, Cunha JP. Success of strabismus surgery in intermittent exotropia. J Pers Med. 2025;15:333. 10.3390/jpm15080333.
10. Lino P, Aguiar P, Cunha JP. Factors associated with the recurrence of intermittent exotropia and reoperations in the long term. Ann Med. 2026;58:2620331. 10.1080/07853890.2026.2620331.
11. Pineles SL, Ela-Dalman N, Zvansky AG, Yu F, Rosenbaum AL. Long-term results of the surgical management of intermittent exotropia. J AAPOS. 2010;14:298–304. 10.1016/j.jaapos.2010.06.007.

Table 5
Multivariable linear regression analyses of final alignment changes

| Outcome model | Treatment contrast | Adjusted β (95% CI), PD | P value | N | $R^2$ |
|---|---|---|---|---|---|
| Final change in distance deviation | BLR recession versus BTX-A injection | 16.43 (14.03–18.84) | < .001 | 343 | 0.547 |
| Final change in near deviation | BLR recession versus BTX-A injection | 16.12 (13.69–18.56) | < .001 | 343 | 0.558 |

The β coefficients represent the adjusted mean differences in the change in deviation associated with BLR recession relative to BTX-A injection. Positive values indicate greater improvement after BLR recession. Models were adjusted for age at intervention and baseline deviation magnitude. Abbreviations: BLR, bilateral lateral rectus; BTX-A, botulinum toxin type A; PD, prism diopters.