Slanted bilateral lateral rectus recession for convergence insufficiency-type intermittent exotropia: a retrospective study

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Abstract

Background The present study sought to investigate the efficiency and safety of SBLR-rec for the treatment of CI-IXT.

Methods This retrospective case series study included 34 patients who underwent SBLR-rec for CI-IXT in Shandong Provincial Hospital affiliated to Shandong University between September 2013 and October 2015 with a minimum follow-up of 6 months. A successful surgical alignment was defined as +5 to -10 prism diopters (PD) of orthophoria in the primary position while viewing distant or near targets and a difference between the distance and near deviation angles of ≤8PD.

Results The mean age of the patients at surgery was 7.09±3.80 years (range, 3 to 18 years). The mean distance deviations were -26.09±6.5 PD (range, -15 to -35 PD) and the mean near deviations, -37.21±6.3 PD (range, -25 to -45 PD) preoperatively. The mean recession amount of upper pole of the lateral rectus was 5.97 mm (range, 4.0 to 7.5mm) and that of lower pole of the lateral rectus, 7.49 mm (range, 6.0 to 8.5mm). At a mean follow-up of 15.0 months (range, 6 to 37 months), the surgical success rate was 70.6% (24/34), the under-correction rate was 17.6% (6/34), and the overcorrection rate was 11.8% (4/34). The mean difference between the distance and near deviation angles was significantly reduced from 11.12±2.06 PD (range, 10 to 15 PD) preoperatively to 2.47±3.04 PD (range, 0 to 10 PD) postoperatively (P<0.001). Each millimeter of difference between the upper and lower poles of the lateral rectus recession was associated with an improvement of 5.65 PD in the near-distance difference of deviation. At the final follow up, a distance-near difference of deviation of ≤8PD was found in 32 (94.1%) patients. none of the patients developed A-V pattern, torsional diplopia, or restricted abduction of the eyes.

Conclusions SBLR-rec for CI-IXT may successfully reduce the distance and near exodeviations and the distance-near deviation difference, thus was proved to be an effective and safe procedure for the treatment of CI-IXT.

Background

Convergence insufficiency-type intermittent exotropia (CI-IXT) is defined as exodeviation greater at near than at distance by at least 10 PD [1]. Non-surgical treatments such as orthoptic treatment, base-in prism reading glasses, vision therapy and psychotherapy could be used to alleviated symptoms in some patients. [2] Surgical management is required for patients that do not respond to these measures or for patients whose deviations are too large or poorly controlled [3]. The various surgical procedures for CI-IXT include unilateral or bilateral medial rectus (MR) resection(s), bilateral lateral rectus (LR) recessions, unilateral LR recession combined with MR resection [4−7], MR resection with adjustable sutures [3], slanted bilateral MR resections [8−10], improved unilateral LR recession combined with MR resection [11−13], and slanted bilateral lateral rectus recession (SBLR-rec) [1−2, 14,15]. The reported success rates range from 13.3−92%. Snir[1] firstly proposed a new procedure of slanted unilateral or bilateral LR recession for both intermittent and constant types of CI-IXT in which the upper pole of the muscle was

recessed according to the distance exodeviation and the lower pole was recessed according to the near exodeviation. It was reported that this procedure was superior in reducing both distance and near deviations and in reducing the distance-near deviation difference. In two other studies performed by Kwon et al [14] and Farid et al [15], this procedure was also proved to be safe and efficient in reducing the distance and near deviation and also the distance-near difference of deviation. However, further studies are still needed. In the present study, we retrospectively analyzed the surgical results of 34 children who underwent SBLR-rec for CI-IXT with a minimum follow-up of 6 months.

Methods

Patients

In this retrospective study, the data of 34 patients with CI-IXT who underwent SBLR-rec between September 2013 and October 2015 were analyzed. Informed written consent for the surgical procedure was obtained from the parents or guardians of the children before surgery according to a protocol approved by the Medical Ethics Committee of Provincial Hospital affiliated to Shandong University for the protection of human subjects (Declaration of Helsinki). Inclusion criteria were as follows: the children with CI-IXT (greater at near than at distance by 10 PD or more); best-corrected visual acuity in the worse eye 20/40 or better and with no interocular difference of visual acuity greater than one line; exodeviation at distance between 15 and 35 PD by the prism and alternate cover test with appropriate optical correction; myopic or hyperopic ⬚5.00D, astigmatism ≤2.00D (based on cycloplegic refraction) and anisometropia≤2.00D. Patients with histories of strabismus surgery, coexisting vertical deviation greater than 5 PD, paralytic or restrictive strabismus, A or V pattern, oblique muscle overaction, ocular disease other than strabismus, congenital anomalies or neurological disorders, and with history of myopic overcorrection, convergence or fusion exercises were excluded from the study.

Methods

Each child underwent full ophthalmologic and orthoptic evaluation including cycloplegic refraction, best-corrected visual acuity, near stereoacuity, motility evaluation, anterior segment assessment, and fundus examination. Prism and alternate cover tests were used to measure the deviation at both distance (6 m) and near (33 cm) with fixation on accommodative targets with their current refractive corrections. General or local anesthesia was performed according to the age or cooperative level of the patients. All surgeries were performed by the same surgeon assisted by a resident. Following a conjunctival cul-de-sac incision, the muscle was disinserted, recessed and sutured directly to the globe. The upper pole of the muscle was recessed according to the distance exodeviation and the lower pole according to near exodeviation. Surgical doses for the LR recession were calculated primarily based on Park's method [16].

The follow-up intervals after operation were determined according to the postoperative status of each patient, but examinations were usually scheduled at 1 day, 6 weeks, 3 months and 6 months postoperatively. Alternate full-time patching was performed in patients with diplopia associated with the initial postoperative overcorrection. Hypermetropia of the overcorrected patients would be fully corrected

if a consecutive esotropia persists for more than 2 weeks. If a constant esotropia of at least 6 PD persisted for 4 weeks, base-out press-on Fresnel prism was prescribed to allow constant fusion until the diplopia or esotropia was resolved.

A successful surgical alignment was defined as an exodeviation (exophoria/ tropia) of 10 PD or less and esodeviation (esophoria/tropia) of 5 PD or less in primary gaze while viewing distant or near targets. Under-correction was defined as postoperative angles >10 PD and overcorrection were defined as postoperative esodeviation >5 PD.

Statistical Analysis

All analyses were performed with SPSS17.0 (StatLab, SPSS for Windows V.17.0). Paired t-test was used to compare the preoperative and postoperative the distance-near deviation differences. A p value of <0.05 was considered statistically significant.

Results

Thirty-four patients were enrolled in this study with 23 males and 11 females. The characteristics of the subjects were shown in Table 1. The mean age at surgery was 7.09±3.80 years old (range, 3～18 years). The preoperative mean exodeviation at distance was -26.09±6.5 PD (range, -15～-35PD), while that at near was -37.21±6.3 PD (range, -25 ～-45 PD), with a distance-near difference of 11.12±2.06 PD (range, 10～15 PD). A mean recession of the upper pole of LR muscle was 5.97 mm (range, 4.0～7.5mm), and that of the lower pole of the muscle 7.49 mm (range, 6.0～8.5mm). The mean follow-up period was 15 months (range, 6～37 months).

Table 1 Characteristics of patients

	Mean±SD (range)
Age at surgery (years)	7.09±3.80(3～18)
male/female	23/11
Equivalent spherical diopter (D, right)	-0.72±1.29(0～-4.00)
Equivalent spherical diopter (D, left)	-0.60±1.20(0～-4.00)
BCVA[#] (LogMAR2[*], right)	0.08±0.13(0.30～0)
BCVA (LogMAR, left)	0.09±0.17(0.30～0)
Deviation at distance (PD)	-26.09±6.5 (-15～-35)
Deviation at near (PD)	-37.21±6.30(-25～-45)
Near-distance difference (PD)	11.12±2.06 (10～15)
Follow-up period (month)	15.01±11.19(6-37)

#BCVA: best corrected visual acuity

*LogMAR: logarithmic minimum angle of resolution

Table 2 shows the surgical outcomes of 34 patients with CI-IXT. At the last follow-up, the successful rate was 70.6 % (24/34), the under-correction rate 17.6% (6/34), and the over-correction rate 11.8% (4/34). The mean distance-near deviation difference was significantly reduced from 11.12±2.06 PD preoperatively to 2.47±3.04 PD postoperatively (P<0.001) (Table 3). The mean deviation angle of 4 patients overcorrected was +8.5PD (range, +6~+12PD) at distance and +9PD (range, 0~+14 PD) at near. One patient overcorrected with a deviation angle of +12PD at distance and +14PD at near undertook a second surgery (unilateral medial rectus recession of 5mm) 7 months after the first surgery and was successfully corrected. The mean deviation angle of 6 patients under corrected was -10.7PD (range, -4~-16PD) at distance, and -16.7PD (range, -14~-20 PD) at near. However, no second surgery was performed as each of them had a good control of the eye till last follow up.

Table 2   Surgical outcomes of patients with CI-IXT

	1 day	1 month	6 months	Last follow-up
Orthotropia (+5~-10PD)	10(29.4%)	25(73.5%)	24(70.6%)	24(70.6%)
overcorrection (>+5PD)	23(67.7%)	5(14.7%)	3(8.8%)	4(11.8%)
undercorrection (>-10PD)	1(2.9%)	4(11.8%)	7(20.5%)	6(17.7%)

Table 3 The distance-near difference before and after surgery (PD)

	Before surgery	After	surgery		
on angles	（range）	1 day	1 month	6 months	Last follow-up
nce	-26.09±6.5 (-15～-35)	8.38±8.08	-0.82±6.17	-2.88±6.50	-2.18±6.85
	-37.21±6.30 (-25～-45)	4.06±9.39	-3.47±6.10	-4.24±7.08	-4.53±7.65
e-near difference	11.12±2.06 (10～15)	4.97±4.48	3.24±3.41	3.24±3.04	2.47±3.04
		<0.001	<0.001	<0.001	<0.001

Each millimeter of difference between the upper and lower poles of the lateral rectus recession was associated with an improvement of 5.65 PD in the distance-near difference of deviation. At the last follow up, the number of patients with a distance-near difference of ≤8PD was 32 (94.1%). A-V pattern, torsional diplopia, or restricted abduction of the eyes was observed in none of the patients.

Discussion

In recent years, various surgical procedures for CI-IXT include unilateral or bilateral MR resection(s) with or without adjustable sutures [3], slanted bilateral MR resections (the upper pole of the MR was resected according to the distance deviation and the lower pole was resected according to the near deviation) [8–10], improved unilateral LR recession combined with MR resection (the LR was recessed according to the distance deviation and the MR was resected according to the near deviation)[10–12], and SBLR-rec (the upper pole of the LR was recessed according to the distance deviation and the lower pole was recessed according to the near deviation) [1–2]. Nemet first and then Biedner performed the slanted bilateral MR resections (SBMR-Res) in 3 patients of CI-IXT respectively, and both reported fairly good outcomes. [8–9] However, their studies had small samples, and 5 of the 6 patients had exodeviations at distance of ＜10PD. In another study of SBMR-Res conducted by Choi in 10 patients of CI-IXT, under corrections were found in all the patients both at distance and at near (with deviations of ≥ 10 PD) after a mean follow up of 38.9 months, only 50% of the patients (5/10) showed a distance-near deviation difference of less than 10PD. [10] Kraft et al performed improved unilateral LR recession combined with MR resection for CI-IXT (the LR was recessed according to the distance deviation and the MR was resected according to the near deviation), got a successful alignment both at distance and at near, and also decreased the distance-near deviation difference.[11] In another study of 14 children with CI-IXT conducted by Choi, a success rate of 42.9% was achieved with this procedure after a follow-up of one year. [12] Wang et al reported that the

improved unilateral LR recession combined with MR resection showed much better effect than unilateral or bilateral MR resections and may work better for CI-IXT patients. [13]

The procedure of slanted horizontal rectus recession and resection for A-V type strabismus was first described by Boyd et al. [17] It was found that each millimeter of difference between the upper and lower poles of the slanted recessed horizontal muscle was associated with an improvement of 3 PD in the distance-near deviation difference. Snir et al firstly adopted the procedure of slanted bilateral or unilateral LR recession for the CI-IXT.[1] In his study group of exotropia (12 patients), the upper pole of the lateral rectus was recessed according to the exodeviation at distance and the lower pole according to the exodeviation at near. While in the control group of exotropia (6 patients), traditional lateral rectus recession was performed. The results showed that the success rate in the study group was 92%, and the mean distance-near deviation difference was reduced from 14 ± 4.5PD preoperatively to 2.9 ± 2.4PD postoperatively. Each millimeter of difference between the upper and lower poles of the slanted recessed LR muscle was associated with an improvement of 4.6 PD in the distance-near deviation difference. While in the control group of 6 patients, neither the postoperative exodeviation at near nor the distance-near deviation difference was satisfying. Snir et al [1] thought that by recessing the lower muscle fibers more than the upper fibers, the exodeviation at near fixation is reduced and the muscle tension of the upper and lower fibers is balanced at the new insertion, which results in a similar alignment of the eye for distance and near. In Chun and Kang's study [2], 31 children with CI-IXT underwent SLR-rec. The results showed that a successful outcome was obtained in 26 of the 31 patients (83.9%). The mean distance-near deviation difference was significantly reduced from 11.0 ± 2.0 PD (range, 10-15PD) to 1.4 ± 2.2 PD (range, 0~8 PD) at 6 months postoperatively. Each millimeter of difference between the upper and lower poles of the slanted recessed LR muscle was associated with an improvement of 8.7 PD in the distance-near deviation difference. At 6 months postoperatively, none of the children demonstrated abduction limitation, diplopia, consecutive esotropia, torsion, or A-V pattern misalignment. In Kwon and Lee's study [14], 53 patients with CI-IXT underwent SLR-rec with a follow-up of more than 12 months. At the last follow up, surgical success rate was 58.5%, and a distance-near deviation difference ≤ 8 PD was measured in 81.1% of patients, which also confirmed the efficiency of SBLR in reducing the distance-near deviation difference. Farid and Abdelbaset [18] compared the three different surgical techniques for treatment of CI-IXT, which were, slanted bilateral LR recession(S-BLR), the improved unilateral medial rectus resection and LR recession (I-RR) with the amounts of resection and recession biased to near and distance deviation respectively, and bilateral augmented LR recession (A-BLR) based on the near deviation. They reported that the success rate of distant exodeviation, near exodeviation, and near-distance disparity in the three groups after 1 year was statistically insignificant. But at the 1-year follow-up, 4 cases in the S-BLR group developed asymptomatic vertical pattern strabismus (V and A patterns) with no diplopia, whereas the rate of postoperative overcorrection and under-correction was significant in the A-BLR and I-RR groups, respectively.

In this retrospective case series study, SBLR-rec was performed in 34 patients of CI-IXT and showed a successful rate of 70.6%, an under-correction rate of 17.6% and an overcorrection rate of 11.8% with a mean follow-up of 15 months. The mean distance-near deviation difference was reduced from 11.03 ±

2.17 PD to 2.47 ± 3.04 PD. Each millimeter of slanting between the upper and lower poles reduced the distance-near deviation difference by 5.65 PD. None of the patients developed A-V pattern, torsional diplopia, or restricted abduction of the eyes.

This study has some limitations. It is a retrospective study and the sample size is relatively small. In addition, a minimum follow-up period of 6 months is a relatively short time because, over time, there may be a further exotropic drift and reduction in surgical success rate. Even so, the results demonstrate that SBLR-rec procedure is effective in reducing the deviation angles of CI-IXT patients at distance and near, and also in reducing the distance-near deviation difference. However, further studies with larger samples, multi center studies and clinical randomized controlled trials with long term of follow-up are still needed.

Conclusions

In summary, our data indicate that SBLR-rec for CI-IXT may successfully reduce the distance and near exodeviations and the distance-near deviation difference, thus was proved to be an effective and safe procedure for the treatment of CI-IXT.

Abbreviations

SBLR-rec
slanted bilateral lateral rectus recession
CI-IXT
convergence insufficiency-type intermittent exotropia;
PD
prism diopters
MR
medial rectus
LR
lateral rectus
BCVA
best corrected visual acuity
LogMAR
logarithmic minimum angle of resolution
SBMR-Res
slanted bilateral medial rectus resections
S-BLR
slanted bilateral LR recession
IRR
the improved unilateral medial rectus resection and lateral rectus recession
A-BLR
bilateral augmented lateral rectus recession

Declarations

Ethics approval and consent to participate

This is a retrospective study. All parents or guardians of the study participants gave written consent for their respective minors to participate in the study. The study protocol was approved by the Ethics Committee of Shandong Provincial Hospital affiliated to Shandong University, Jinan, China (No.2018-056). All procedures strictly adhered to the principles of the Declaration of Helsinki.

Consent for publication

Not applicable

Competing interests

There are no competing interests to declare in relation to this work.

Availability of data and materials

The datasets of the current study are available from the corresponding author on reasonable request.

Authors' contributions

LW, MR and QW participated in design and coordination of the study,

carried out the clinical examinations, diagnosis and follow-up the patients. LW and MR drafted the manuscript. LW have given final approval of the version to be published. All authors read and approved the final manuscript.

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