



## Two cases of acquired bilateral trochlea nerve palsy treated by simultaneous inferior rectus muscle nasal transposition and inferior oblique muscle myectomy

Miwa Komori, Hiroko Suzuki, Hirohito Iimori, Akiko Hikoya, Yoshihiro Hotta, Miho Sato\*

Department of Ophthalmology, Hamamatsu University School of Medicine, 1-20-1 Handayama, Higashi-ku, Hamamatsu City, Shizuoka, 431-3192, Japan

### ARTICLE INFO

#### Keywords:

Acquired strabismus  
Excyclotorsion  
Inferior rectus muscle  
Inferior oblique muscle  
Trochlea nerve palsy

### ABSTRACT

**Purpose:** To report two cases of acquired bilateral trochlea nerve palsy with large torsional deviation successfully treated by simultaneous bilateral inferior rectus muscle (IR) nasal transposition and inferior oblique muscle (IO) myectomy.

**Observations:** Case 1 was of a 54-year-old man with torsional diplopia after a traffic accident. He showed 32° and 38° excyclotorsion in the primary and downward gazes, respectively. Case 2 was of a 56-year-old woman with torsional diplopia after a brain tumor operation. She showed 25° and 33° excyclotorsion in the primary and downward gazes, respectively. We simultaneously performed bilateral IR nasal transposition and IO myectomy in these two cases. Postoperatively, case 1 presented with improved excyclotorsion, with 2° and 7° excyclotorsion in the primary and downward gazes, respectively; case 2 similarly presented with improved excyclotorsion, with 4° and 12° excyclotorsion in the primary and downward gazes, respectively.

**Conclusions and importance:** Simultaneous bilateral IR nasal transposition and IO myectomy are effective for treating large-angle torsional deviations, especially in downward gaze, requiring only one operation. A new surgical approach is suggested for the successful treatment of large torsional deviations, requiring only one operation.

### 1. Introduction

Acquired bilateral trochlea nerve palsy often occurs after closed head injury and presents a small vertical deviation in the primary position, large V pattern, large torsional deviation usually exceeding 15° in the primary position, and a bilaterally positive Bielschowsky head tilt test (BHTT).<sup>1</sup> A recent study reported that only 70% of superior oblique palsy patients fulfill the Parks 3 step test<sup>2</sup>; moreover, another study reported that only 40% of true bilateral traumatic superior oblique paresis had a positive Bielschowsky head tilt test on both sides, which may mask the bilateral palsy.<sup>3</sup> Therefore, it is recommended to comprehensively judge the diagnosis of bilateral superior oblique palsy and trochlea nerve paresis based on the history, clinical findings including large torsional diplopia, and imaging findings if possible.

The possible techniques for torsional deviation treatment of acquired trochlea nerve palsy include inferior oblique muscle (IO) myectomy, recession, anterior transposition and nasal transposition, superior oblique (SO) tendon tuck, Harada–Ito procedure, and contralateral inferior

rectus muscle (IR) recession with/without nasal transposition. However, these procedures are not sufficient for the treatment of large torsional deviations, especially those exceeding 15° in the primary position, when performed individually.

The double Maddox rod and synoptophore tests are subjective tests used to evaluate torsional deviation. They can measure the torsion of the primary and nine gaze positions, respectively, in detail. Moreover, fundus photography confirms objective torsional deviation. In normal individuals, the macula is located between the lines drawn horizontally from the center and lower edge of the optic disc. However, in case of excyclotorsional deviation, the macula is positioned further below the lower edge of the optic disc.

Here, we report two cases of simultaneously performed bilateral IR nasal transposition and IO myectomy for the successful treatment of large-angle torsional deviation.

\* Corresponding author.

E-mail address: [mihosato@hama-med.ac.jp](mailto:mihosato@hama-med.ac.jp) (M. Sato).

<https://doi.org/10.1016/j.ajoc.2021.101011>

Received 29 January 2020; Received in revised form 11 November 2020; Accepted 4 January 2021

Available online 12 January 2021

2451-9936/© 2021 Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

2. Findings

2.1. Case 1

Case 1 was of a 54-year-old man with torsional diplopia for 30 years caused by a traffic accident. He was referred to our hospital for a gradual increase in the frequency of excyclotorsion. Best corrected visual acuity (BCVA) equivalent to Snellen acuity were 20/15 and refractive errors were  $-0.50D$  OU. Eye position examination showed that he had 6 prism diopters (PD) left intermittent hypertropia at distance and 6 PD exophoria at near via an alternate prism cover test (APCT). He showed a positive BHRT to the left, and bilateral IO overactions and SO underactions. The Titmus stereotest result was Fly (-). The double Maddox rod test revealed  $30^\circ$  excyclotorsion. He showed  $1^\circ$  exotropia, and  $4^\circ$  and  $12^\circ$  esotropia with synoptophore, which is equivalent to 2 PD exotropia, and 7, 21 PD esotropia (PD = degree x 1.74) in the upward, primary, and downward gazes, respectively. He also exhibited  $26^\circ$ ,  $32^\circ$ , and  $38^\circ$  excyclotorsion in the upward, primary, and downward gazes, respectively, as estimated by the synoptophore; the synoptophore often shows different horizontal eye position results from APCT due to the intervention of accommodation by looking into the device. We indicated nine gaze positions of cyclotorsion on the synoptophore (Fig. 1A); fundus photography revealed bilateral excyclotorsion (Fig. 2A).

Bilateral IR surgery of 1 muscle-width nasal transposition (no recession) and IO myectomy were simultaneously scheduled under general anesthesia. We performed first the IO myectomy and then IR nasal transposition as follows (Fig. 3): after a conjunctival incision, the IR was hooked with a muscle hook; a 6-0 absorbable suture was then passed through the tendon and the muscle was detached from the sclera. In this case, the muscle was transposed nasally by 1 muscle-width without recession; thus, the temporal end of the IR was sutured at the nasal end of the insertion. The same distance (1 muscle-width) was measured nasally along the spiral of Tillaux and the other end of the suture was passed through the sclera. Both eyes underwent this operation.

Postoperatively, the patient's eye position presented ortho at a distance and 6 PD exophoria at near using APCT. The Titmus stereotest results improved to Fly (+), Animal 3/3, and Circle 6/9; the double Maddox rod test also improved to  $1^\circ$  excyclotorsion; he displayed  $0^\circ$ ,  $0^\circ$ , and  $3^\circ$  (equivalent 0, 0, 5 PD) esotropia in the upward, primary, and downward gazes, respectively. He also indicated  $0^\circ$ ,  $2^\circ$ , and  $7^\circ$  excyclotorsion in the upward, primary, and downward gazes, respectively, estimated by the synoptophore. We indicated nine gaze positions of cyclotorsion on the synoptophore (Fig. 1B), and bilateral excyclotorsion indicated by fundus photography improved (Fig. 2B). The binocular single vision field of view gradually improved and eye position had not changed even 1 year after surgery.

2.2. Case 2

Case 2 was of a 56-year-old woman with torsional diplopia after a brain tumor operation. She was referred to our hospital for excyclotorsion and V pattern esotropia. BCVA equivalent to Snellen acuity were 20/15 OU, and refractive errors were  $-2.25D$  cyl  $-1.50D$  Ax  $20^\circ$  OD,

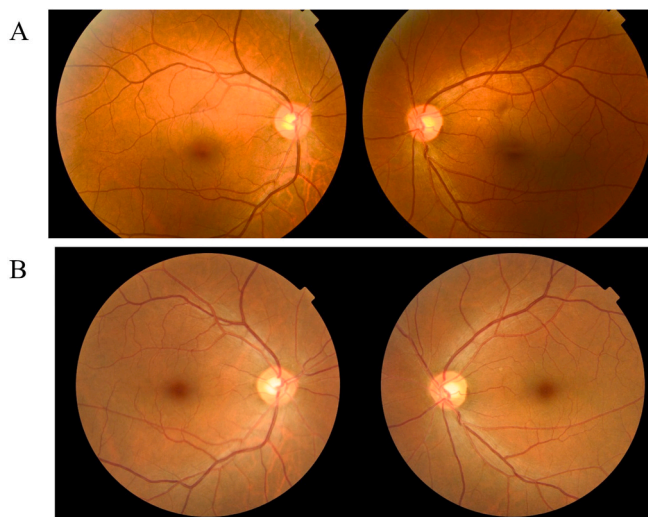


Fig. 2. Preoperative (A) and postoperative (B) fundus photography of the patient in case 1, showing bilateral excyclotorsion (A) that was improved after operation (B).

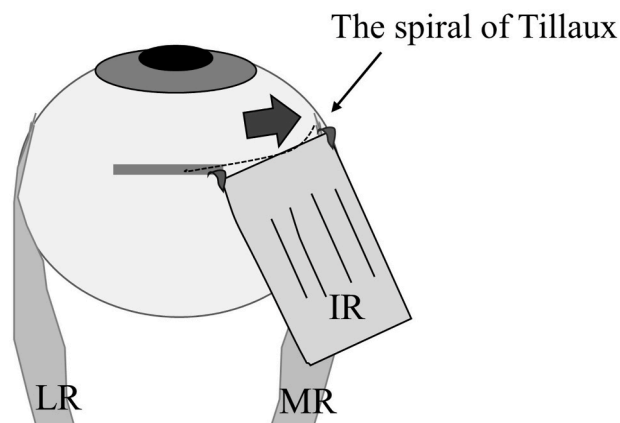


Fig. 3. The IR nasal transposition procedure where we moved IR 1 muscle-width nasally along the spiral of Tillaux. IR: inferior rectus muscle, MR: medial rectus muscle, LR: lateral rectus muscle.

and  $-4.75D$  cyl  $-1.00D$  Ax  $160^\circ$  OS. Eye position examination showed 10 PD esotropia and 6 PD right hypertropia at a distance and 18 PD esotropia at near via APCT. She presented with V pattern esotropia (8 PD esotropia and 10 PD right hypertropia in the upward gaze, and 25 PD esotropia in the downward gaze) and showed a positive BHRT to the right, and bilateral IO overactions and SO underactions. The Titmus stereotest result was Fly (-). The double Maddox rod test results showed  $30^\circ$  excyclotorsion. She showed  $11^\circ$ ,  $14^\circ$ , and  $18^\circ$  (equivalent 19, 24, 31 PD) esotropia, in the upward, primary, and downward gazes, respectively; and  $25^\circ$ ,  $25^\circ$ , and  $33^\circ$  excyclotorsion in upward, primary, and

A				B			
Ex $28^\circ$	Ex $26^\circ$	Ex $24^\circ$		$0^\circ$	$0^\circ$	In $1^\circ$	
Ex $32^\circ$	Ex $32^\circ$	Ex $32^\circ$		Ex $3^\circ$	Ex $2^\circ$	Ex $1^\circ$	
Ex $38^\circ$	Ex $38^\circ$	Ex $35^\circ$		Ex $9^\circ$	Ex $7^\circ$	Ex $6^\circ$	

Fig. 1. Nine synoptophore gaze positions of the patient in case 1. A: preoperative score, B: Twelve-month postoperative score. Ex: excyclotorsion, In: incyclotorsion.

downward gazes, respectively, estimated by the synoptophore. We indicated nine gaze positions of cyclotorsion on the synoptophore (Fig. 4A) and fundus photography revealed bilateral excyclotorsion (Fig. 5A).

We simultaneously performed bilateral IR 3/4 muscle-width nasal transposition, without recession in the right eye and 2-mm recession in the left eye for correcting right hypertropia, IO myectomy, and 5-mm right medial rectus muscle (MR) recession for esotropia under general anesthesia. We performed first the IO myectomy and next the IR nasal transposition procedure, as in case 1, with the addition of MR recession in the right eye (different from Fig. 3). We predicted that the surgical effect of IR recession was 2.2 PD/mm based on our previous research results,<sup>4</sup> the muscle was transposed nasally 3/4 muscle-width without recession in the right eye and with a 2-mm recession in the left eye for 6 PD right hypertropia at distance.

After surgery, the patient's eye position presented 8 PD esotropia at a distance and 14 PD intermittent esotropia at near via APCT; V pattern esotropia remained (16 PD and 25 PD esotropia in the upward and downward gazes, respectively). The Titmus stereotest result was improved to Fly (+), Animal 0/3, and Circle 2/9. The double Maddox rod test also improved to 1° excyclotorsion. She showed 13°, 17°, and 17° (equivalent 23, 30, 30 PD) esotropia in the upward, primary, and downward gazes, respectively; and 3°, 4°, and 12° excyclotorsion in the upward, primary, and downward gazes, respectively, as measured by the synoptophore. We indicated nine gaze positions of cyclotorsion on the synoptophore (Fig. 4B). Bilateral excyclotorsion indicated by fundus photography improved (Fig. 5B). Eye position had not changed even 1 year postoperatively. At the last follow-up, she was wearing prism glasses for residual esotropia and the large excyclotorsion had improved.

### 3. Discussion

We have previously reported that congenital superior oblique palsy patients with loose superior oblique tendon and vertical deviation larger than 15 PD are good candidates for simultaneous surgery, including inferior oblique weakening and superior oblique tuck procedure.<sup>5</sup> Although congenital superior oblique palsy patients show large fundus torsion, unlike acquired trochlea nerve palsy patients, they usually do not complain of torsional diplopia.

Here, we reported the cases of a 54-year-old man and a 56-year-old woman with injury-induced large-angle torsional diplopia who underwent curative simultaneous bilateral IR nasal transposition and IO myectomy without significantly affecting the horizontal eye position.

Two cases were diagnosed with and treated for acquired bilateral trochlear nerve palsy, based on a history of severe closed head trauma, a small vertical deviation in the primary position, a large torsional deviation in the primary position increased in the downward gaze, a bilateral IO overactions and SO underactions, a V pattern, and a bilateral excyclotorsion indicated on a fundus photograph.

Several techniques are known as possible therapeutic procedures for torsional deviation of acquired trochlea nerve palsy. There remains a controversy about the effectiveness of IO myectomy and the graded IO recess procedure for correcting IO overaction.<sup>6-9</sup> We prefer IO myectomy when it is scheduled simultaneously with the IR nasal

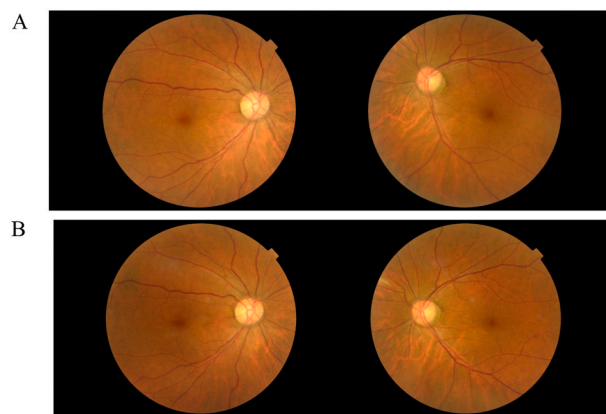


Fig. 5. Preoperative (A) and postoperative (B) fundus photography of the patient in case 2, showing bilateral excyclotorsion (A) that was improved after the operation (B).

transposition procedure because of the congestion at the muscle suture site.

Regarding the corrective effects of the Harada-Ito procedure in cyclotorsion, Bradfield et al.<sup>10</sup> reported 8° and 12° by unilateral and bilateral SO tendon advancement, respectively; Nishimura and Rosenbaum<sup>11</sup> also reported 9.7° by unilateral surgery. Arici and Oguz<sup>12</sup> reported the effectiveness of SO tuck and IO weakening procedures on subjective and objective torsion; according to their report, the mean decrease in subjective extorsion was 6.2° after SO tuck, 2.3° after IO anterior transposition, 1.3° after IO recession, and 2.6° after IO myectomy and objective extorsion decreased by 5.8°, 4.4°, 3.1°, and 3.4°, respectively. Lee et al.<sup>13</sup> also reported the effectiveness of IO myectomy for a 9.0° decrease in extorsion using digital fundus photographs. Stager et al.<sup>14,15</sup> reported anteronasal transposition of the IO and described that when the IO was placed anteriorly and nasally to the IR, it was converted from excyclotorsion to incyclotorsion. More recently, Saxena et al.<sup>16</sup> reported the corrective effects of IO anterior and nasal transpositions at 18.5° in 12 patients.

Unilateral IR recession with nasal transposition was reported by von Noorden et al.<sup>17</sup> and they indicated its effectiveness for correcting cyclotorsion by as much as 5.8°. Ohmi et al.<sup>18</sup> reported its corrective efficacy at 7.8°, while Nemoto et al.<sup>19</sup> reported it at 6.4°, and Okamoto et al.<sup>20</sup> at as much as 5.6° in a large patient group. They also reported<sup>20</sup> bilateral IR nasal transposition at 10.9°. In these reports, the muscle was transposed nasally by 1 muscle-width. IR surgery is a simple and effective technique for correcting both torsional and vertical deviation. When the IR is transposed nasally, the procedure effectiveness on torsion is enhanced.

However, one operation is not sufficient to correct a large torsional deviation of ≥20° in the primary position in any of the aforementioned procedures, as in the two cases presented, and additional operations are often required. Further, in acquired bilateral trochlea nerve palsy, in addition to the primary position, the torsional deviation is particularly large in the downward gaze. Because patients often have to look

A

Ex 25°	Ex 25°	Ex 25°
Ex 25°	Ex 25°	Ex 25°
Ex 35°	Ex 33°	Ex 33°

B

Ex 3°	Ex 3°	Ex 3°
Ex 5°	Ex 4°	Ex 4°
Ex 12°	Ex 12°	Ex 7°

Fig. 4. Nine synoptophore gaze positions of the patient in case 2. A: preoperative score, B: Twelve-month postoperative score. Ex: excyclotorsion.

downward from the primary gaze (e.g., when cooking, writing, reading books, watching mobile phones, or using computers), this is a major obstacle in daily life. However, there have been no reports on the effects of correcting downward gaze torsional deviation. In this report, by simultaneously performing bilateral IR nasal transposition and IO myectomy, the excyclotorsional correction effect in case 1 was 30° and 31° in the primary and downward gazes, respectively, and 21° in both primary and downward gazes in case 2. In addition, by adding a small amount of IR recession in only the right eye, vertical deviation was corrected in case 2. Therefore, we could correct a large-angle torsional deviation in one operation and improve torsional and vertical diplopia without significantly affecting the horizontal eye position in these two cases. The torsional corrective effect of bilateral IR nasal transposition and IO myectomy performed simultaneously exceeds the sum of the torsional corrective effects of only IO myectomy or IR nasal transposition. The synergistic effect is currently unknown and requires further research. Since the number of cases was still small and the torsional correction effect was uncertain in simultaneous surgery involving bilateral IR nasal transposition and IO myectomy, we were concerned about an overcorrection in case 2. Therefore we limited the movement to 3/4 muscle-width instead of 1 muscle-width. Further studies should consider increasing the sample size.

#### 4. Conclusions

Simultaneous surgery of bilateral IR nasal transposition and IO myectomy is effective for treating large-angle torsional deviation in a single operation. This may prove beneficial as simultaneous surgery could contribute to sparing time, resources, patient distress, and risks associated with repeat operations.

#### Patient consent

This study protocol was reviewed and approved by the institutional review board of the Hamamatsu University School of Medicine (No. 17–195). The patients provided verbal consent for case publication.

#### Funding

This study was supported by research grants from Japan Society for the Promotion of Science Grant-in-Aid for Early-Career Scientists (No. JP18K16952) (<https://www.jsps.go.jp/english/index.html>). The funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

#### Authorship

All authors attest that they meet the current ICMJE Criteria for Authorship.

#### Declaration of competing interest

The following authors have no financial disclosures: MK, HS, HI, AH,

YH, MS.

#### Acknowledgments

We would like to thank Editage ([www.editage.jp](http://www.editage.jp)) for English language editing.

#### References

- Kraft SP, O'Reilly C, Quigley PL, Allan K, Eustis HS. Cyclotorsion in unilateral and bilateral superior oblique paresis. *J Pediatr Ophthalmol Strabismus*. 1993;30(6):361–367.
- Manchandia AM, Demer JL. Sensitivity of the three-step test in diagnosis of superior oblique palsy. *J AAPOS*. 2014;18(6):567–571.
- Muthusamy B, Irsch K, Peggy Chang HY, Guyton DL. The sensitivity of the Bielschowsky head-tilt test in diagnosing acquired bilateral superior oblique paresis. *Am J Ophthalmol*. 2014;157(4):901–907.
- Komori M, Suzuki H, Hikoya A, Sawada M, Hotta Y, Sato M. Effect of vertical deviation of contralateral inferior rectus muscle recession in superior oblique palsy. *J Jpn Ophthalmol Soc*. 2019;123(1):45–50.
- Komori M, Suzuki H, Hikoya A, Sawada M, Hotta Y, Sato M. Evaluation of surgical strategy based on the intraoperative superior oblique tendon traction test. *PLoS One*. 2016;11(12): e0168245.
- Nucci P. Superior oblique palsy: promoting a simpler approach. *Eur J Ophthalmol*. 2006;16(1):1–2.
- Bahl RS, Marcotty A, Rychwalski PJ, Traboulsi EI. Comparison of inferior oblique myectomy to recession for the treatment of superior oblique palsy. *Br J Ophthalmol*. 2013;97(2):184–188.
- Rajavi Z, Molazadeh A, Ramezani A, Yaseri M. A randomized clinical trial comparing myectomy and recession in the management of inferior oblique muscle overaction. *J Pediatr Ophthalmol Strabismus*. 2011;48(6):375–380.
- Ghazawy S, Reddy AR, Kipiotti A, McShane P, Arora S, Bradbury JA. Myectomy versus anterior transposition for inferior oblique overaction. *J AAPOS*. 2007;11(6):601–605.
- Bradfield YS, Struck MC, Kushner BJ, Neely DE, Plager DA, Gangnon RE. Outcomes of Harada-Ito surgery for acquired torsional diplopia. *J AAPOS*. 2012;16(5):453–457.
- Nishimura JK, Rosenbaum AL. The long-term torsion effect of the adjustable Harada-Ito procedure. *J AAPOS*. 2002;6(3):141–144.
- Arici C, Oguz V. The effect of surgical treatment of superior oblique muscle palsy on ocular torsion. *J AAPOS*. 2012;16(1):21–25.
- Lee J, Suh SY, Choung HK, Kim SJ. Inferior oblique weakening surgery on ocular torsion in congenital superior oblique palsy. *Int J Ophthalmol*. 2015;8(3):569–573.
- Stager Sr DR, Beauchamp GR, Stager Jr DR. Anterior and nasal transposition of the inferior oblique muscle: a preliminary case report on a new procedure. *Binocul Vis Strabismus Q*. 2001;16(1):43–44.
- Stager Jr DR, Beauchamp GR, Wright WW, Felius J, Stager DR. Anterior and nasal transposition of the inferior oblique muscles. *J AAPOS*. 2003;7(3):167–173.
- Saxena R, Sharma M, Singh D, Sharma P. Anterior and nasal transposition of inferior oblique muscle in cases of superior oblique palsy. *J AAPOS*. 2017;21(4):282–285.
- von Noorden GK, Jenkins RH, Chu MW. Horizontal transposition of the vertical rectus muscles for cyclotropia. *Am J Ophthalmol*. 1996;122(3):325–330.
- Ohmi G, Fujikado T, Ohji M, Saito Y, Tano Y. Horizontal transposition of vertical rectus muscles for treatment of excyclotropia. *Graefes Arch Clin Exp Ophthalmol*. 1997;35(1):1–4.
- Nemoto Y, Kaneko H, Sakaue T, Kobota N, Maruo T, Oshika K. Skew transposition of vertical rectus muscles for excyclovertical deviation. *JPN J Ophthalmol*. 2000;44(4):428–432.
- Okamoto M, Kimura A, Masuda A, Mimura O. Surgical effects of nasal transposition of inferior rectus muscle - 135 cases of acquired superior oblique palsy. *Clin Ophthalmol*. 2015;9:691–695.