Unilateral Inferior Oblique Anterior Transposition for Asymmetric Dissociated Vertical Deviation with Unilateral Inferior Oblique Over-action

Shuang-Qing Wu  
Hangzhou Red Cross Hospital

Qi-Bin Xu  
Hangzhou Red Cross Hospital

Wen-Yan Sheng  
Hangzhou Red Cross Hospital

Li-Wei Zhu (✉ zwgsy@163.com)  
Hangzhou Red Cross Hospital

Research article

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Abstract

Background: To evaluate the results of unilateral inferior oblique anterior transposition (IOAT) for dissociated vertical deviation (DVD) combined with inferior oblique over-action (IOOA). Methods: Retrospective chart review of the records of all patients with asymmetric DVD combined with unilateral IOOA in the non-dominant eye, who received unilateral IOAT on the non-dominant eye. No other muscles were operated simultaneously. The amount of DVD and IOOA before and after the operation was measured and statistically analyzed. Results: Seventeen patients were included. Mean age at surgery was 23.5 ± 8.4 years (range 12 - 38). The mean postoperative follow-up period was 15.7 ± 7.2 months (range 6 - 32). Primary position DVD was 19.6 ± 5.4 PD (range 14 - 36) preoperatively, which decreased significantly to 2.9 ± 2.0 PD (range 0 - 8) postoperatively (P < 0.01). There were 2, 7, and 8 patients with +1, +2, and +3 IOOA preoperatively, respectively, which was reduced significantly to 0.3 ± 0.4 postoperatively. Conclusions: Unilateral IOAT was recommended in patients with asymmetric DVD coexists with unilateral IOOA.

Background

Dissociated vertical deviation (DVD) is an ocular motor disorder characterized by upward drifting of one or both eye when the other eye is fixing on a target. It was an abnormal vertical movement of eye ball, contradictory with the role of nerve domination[1]. When DVD coexisted with inferior oblique over-action (IOOA), inferior oblique anterior transposition (IOAT) was recommended [2-7]. It was an ideal method to reduce the strength of inferior oblique and restrict floating phenomenon of DVD synchronously. Most clinicians suggested that binocular DVD should be treated with binocular surgery, especially for symmetric DVD [5-6]. However, treatment decisions for asymmetric DVD were more complex, asymmetric [8-9] or unilateral [4] surgery may be considered. Unilateral IOAT has been reported satisfied outcomes in some studies despite some possible adverse outcomes, such as hypotropia and antielevation syndrome [2,4,10]. We considered this surgical design could acquire approving results with the least damage. The purpose of this study is to analysis outcomes and complications of a cohort of patients, who underwent unilateral IOAT for the treatment of asymmetric DVD combined with unilateral IOOA.

Methods

A retrospective chart review was conducted on all of the patients who received unilateral IOAT for DVD at Hangzhou Red-Cross Hospital between March 2015 and September 2017. Those subjects with significant asymmetric DVD, unilateral IOOA, and receiving surgery on the non-dominant eye with IOOA were included. A minimum postoperative follow-up period of 6 months was included in the analysis. Patients were excluded if they have not IOOA or alternate fixation. Patients with previous strabismus surgery, neurologic, genetic, or craniofacial abnormalities were also excluded.

Besides regular ophthalmological examinations, DVD was measured by using the prism and alternate cover test with the eyes in the primary position, fixating on an accommodative target at distance (6-m)
and near (1/3-m) deviations in the primary position with full refractive correction. The fixating eye was
changed to evaluate the difference in vertical deviation between the eyes. A difference of 5 PD or more
was defined as asymmetric DVD. The degree of the IOOA was measured in the field of action of inferior
oblique and estimated from +1 to +4, as described previously[11].

All surgeries were performed by a same surgeon (LWZ). In all patients, the eye with more DVD underwent
IOAT. It was performed by a temporal inferior fornix approach with a 6-mm conjunctival incision. Tenon's
capsule was incised and the sclera was exposed. The lateral and inferior recti were isolated by muscle
hooks, which maintain the eye in a position of elevation and adduction. The distal end of the inferior
oblique was identified and imbricated with 6-0 Vicryl sutures and dissected from the sclera. The inferior
oblique was transported and fixed on the same horizontal superficial sclera adjacent to the inferior rectus
insertion, 1 mm posterior to the inferior rectus insertion for +1 to +2 IOOA, at the level of the insertion for
+3 IOOA, and 1 mm anterior to the insertion for +4 IOOA. The muscle was reattached to the sclera by a
crossed swords technique. The overlying conjunctiva was closed with interrupted 8-0 Vicryl sutures.
Horizontal extraocular muscle surgery to correct congenital esotropia or exotropia was performed with
secondary operation 3 months after IOAT.

Postoperative follow-ups were performed at 1 week, 1 month, and 3 months, and then seen every 3 – 6
months, on average. A successful outcome was defined as a residual DVD of less than 10 PD of primary
position and an IOOA of ≤+1.

Continuous variables were expressed as mean and standard deviation, and compared using a two-sided
student’s t-test. Discrete various were compared using a Wilcoxon Signed Ranks test before and after the
operation. A P-value < 0.05 was considered statistically significant.

**Results**

Seventeen subjects met the study inclusion criteria and the mean age at surgery was 23.5 ± 8.4 years
(range 12 to 38 years). Among them, there were 6 males and 11 females. Two patients had congenital
exotropia and 5 patients had esotropia. The mean postoperative follow-up period was 15.6 ± 7.2 months
(range 6 to 32 months). Primary position DVD was 19.6 ± 5.4 PD (range 14 to 36 PD) preoperatively.
There were 2, 7, and 8 patients with +1, +2, and +3 IOOA preoperatively, respectively.

Postoperatively, primary position DVD reduced to 2.9 ± 2.0 PD (range 0 to 8 PD), which was significantly
different with preoperative DVD (P < 0.01). Compared with preoperative mean value as 2.4 ± 0.7, IOOA
decreased significantly to 0.3 ± 0.4 postoperatively.

None of the patients developed obvious hypotropia, anti-elevation syndrome and IOOA in the contralateral
eye postoperatively. DVD and IOOA were successfully corrected in all cases (Fig. 1).

**Discussion**
The management of DVD is challenging for strabismus surgeons. Multiple approaches have been proposed for treatment for DVD. Superior rectus recession and IOAT were most regular procedures. When DVD coexisted with IOOA, IOAT is preferred, which reduces the IOOA and restricts superior floating phenomenon of DVD simultaneously [4,6,8-9,12]. Full IOAT includes the posterior fibers with J deformity, which formed a neurofibrovascular bundle. The neurovascular bundle provides the inferior oblique a new functional origin and converses the inferior oblique from an elevator to a depressor. The depressor effect is likely own to a combination of active contraction of the distal inferior oblique and a mechanical restriction to elevation of the eye [8,13].

Satisfied clinical results of IOAT for DVD with IOOA were reported in recent years [2-6]. Symmetric DVD was always treated with symmetric surgery, whereas asymmetric DVD or IOOA were more challenging. Pineles et al [9] used asymmetric IOAT to treat 14 patients with incomitant asymmetric DVD and resulted in improvements of incomitant DVD, V-pattern and IOOA. Snir et al [8] suggested bilateral IOAT with monocular-graded inferior oblique resection for asymmetric DVD with IOOA. Bothun and Summers [4] considered unilateral IOAT was an effective treatment for unilateral or markedly asymmetric DVD in patients with a strong, contralateral fixation preference. We restricted the similar inclusion criteria with Bothun's and achieved comparable results with previous studies.

For IOAT surgery, the optimal placement of the muscle was controversial. The standard placement was at the temporal border of the inferior rectus muscle insertion. Recently, Fard [6] suggested inferior oblique anterior nasal transposition might mechanically restrict elevation of the eye, and achieved satisfied results for DVD with IOOA. Engman et al [14] considered more anterior placement of the inferior oblique does not increase its effectiveness. Mims and Wood [15] placed the inferior oblique to a position 2 to 4 mm anterior to the lateral end of inferior rectus muscle insertion. Seawright and Gole [16] performed graded IOAT to positions located 2 mm posterior to and 2 mm anterior to the temporal position of the inferior rectus insertion according to the presence or amount of preoperative IOOA, V pattern, hypertropia, and DVD. Kratz [17] graded 1 mm posterior to and 1 mm anterior to the temporal position of the inferior rectus insertion based on the severity of DVD. We performed similar placement position as Kratz's, but we graded for the position based on the degree of IOOA. In the monocular procedure, we achieved satisfied result by reducing the unilateral IOOA from 2.4 to 0.3.

With the generalization IOAT, some side-effects were mentioned, such as hypotropia [5-6,18], anti-elevation syndrome [5,15,19], and increased IOOA in the contralateral eye postoperatively [18]. Even though hypotropia and anti-elevation were also reported in the unilateral IOAT surgery, the complications were often transient or mild [4,10]. In our study, IOOA and DVD were significantly reduced in all patients and there were no related complications. Postoperatively, no change was found in our patients about contralateral eye DVD, IOOA, diplopia, and fixing property. It was probably related to our inclusion criteria with unilateral IOOA, significantly different primary position DVD in both eyes, and surgery on non-fixing eye. Because non-fixing eye always occupied higher position, IOAT on non-fixing eye could improve floating phenomenon of DVD, with less complications.
In conclusion, according to the retrospective study, for patients with asymmetric DVD coexist with unilateral IOOA, unilateral IOAT could be recommended.

**Abbreviations**

IOAT: inferior oblique anterior transposition; DVD: dissociated vertical deviation; IOOA: combined with inferior oblique over-action; PD: prism degree.

**Declarations**

**Ethics approval and consent to participate**

A retrospective chart review was conducted on all of the patients at Hangzhou Red-Cross Hospital. This study was approved by the Institutional Review Board at Hangzhou Red-Cross Hospital. Written informed consents were obtained from all participants.

**Consent for publication** Approval consent for publication of the photo was attained from the patient herself.

**Availability of data and materials**

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

**Competing interests**

**The authors declare that they have no competing interests.**

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**Authors’ contributions**

SQW and LWZ drafted this manuscript, collected the data, and reviewed the literature. QBX and WYS interpreted the data and critically reviewed the manuscript. All authors have read and approved the final manuscript.

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**References**
1. Brodsky MC. Dissociated vertical divergence: a righting reflex gone wrong. *Arch Ophthalmol* 1999;117(9):1216-22.

2. Burke JP, Scott WE, Kutshke PJ. Anterior transposition of the inferior oblique muscle for dissociated vertical deviation. *Ophthalmology* 1993;100(2):245-50.

3. Black BC. Results of anterior transposition of the inferior oblique muscle in incomitant dissociated vertical deviation. *J AAPOS* 1997;1(2):83-7.

4. Bothun ED, Summers CG. Unilateral inferior oblique anterior transposition for dissociated vertical deviation. *J AAPOS* 2004;8(3):259-63.

5. Nabi R, Anvari F, Azadeh M, Ameri A, Jafari AK. Evaluation of the effectiveness of anterior transposition of the inferior oblique muscle in dissociated vertical deviation with or without inferior oblique overaction. *J Pediatr Ophthalmol Strabismus* 2007;44(3):158-62.

6. Fard MA. Anterior and nasal transposition of the inferior oblique muscle for dissociated vertical deviation associated with inferior oblique muscle overaction. *J AAPOS* 2010;14(1):35-8.

7. Hatt SR, Wang X, Holmes JM. Interventions for dissociated vertical deviation. *Cochrane Database Syst Rev* 2015; doi:10.1002/14651858.

8. Snir M, Axer-Siegel R, Cotlear D, Sherf I, Yassur Y. Combined resection and anterior transposition of the inferior oblique muscle for asymmetric double dissociated vertical deviation. *Ophthalmology* 1999;106(12):2372-6.

9. Pineles SL, Velez G, Velez FG. Asymmetric inferior oblique anterior transposition for incomitant asymmetric dissociated vertical deviation. *Graefes Arch Clin Exp Ophthalmol* 2013;251(11):2639-42.

10. Milot J, Tremblay C, Ouellette C. Anterior transposition of the inferior oblique for dissociated vertical deviation with inferior oblique overaction. *Can J Ophthalmol* 1994;29:284-7.

11. Iizuka M. Color Atlas of Strabismus Surgery: Strategies and Techniques. In: Kenneth W. Wright, M.D. Sonal Farzavandi, editors. New York: Academic; 2006. p .233-255.

12. Yoo EJ, Kim SH. Modified inferior oblique transposition considering the equator for primary inferior oblique overaction (IOOA) associated with dissociated vertical deviation (DVD). *Strabismus* 2014;22(1):13-7.

13. Stager DR, Weakley DR, Jr., Stager D. Anterior transposition of the inferior oblique. Anatomic assessment of the neurovascular bundle. *Arch Ophthalmol* 1992;110(3):360-2.

14. Engman JH, Egbert JE, Summers CG, Young TL. Efficacy of inferior oblique anterior transposition placement grading for dissociated vertical deviation. *Ophthalmology* 2001;108(11):2045-50.

15. Mims JL, 3rd, Wood RC. Antielevation syndrome after bilateral anterior transposition of the inferior oblique muscles: incidence and prevention. *J AAPOS* 1999;3(6):333-6.

16. Seawright AA, Gole GA. Results of anterior transposition of the inferior oblique. *Aust N Z J Ophthalmol* 1996;24(4):339-45.

17. Kratz RE, Rogers GL, Bremer DL, Leguire LE. Anterior tendon displacement of the inferior oblique for DVD. *J Pediatr Ophthalmol Strabismus* 1989;26:212-7.
18. Quinn AG, Kraft SP, Day C, Taylor RS, Levin AV. A prospective evaluation of anterior transposition of the inferior oblique muscle, with and without resection, in the treatment of dissociated vertical deviation. *J AAPOS* 2000;4(6):348-53.

19. Kushner BJ. Restriction of elevation in abduction after inferior oblique anteriorization. *J AAPOS* 1997;1(1):55-62.

**Figures**

*Figure 1*

Figure 1A - A patient example with DVD coexisted with IOOA who received unilateral inferior oblique anterior transposition in the left eye. A. Pre-operative findings in a patient. Note +3 IOOA and 36 PD DVD in the left eye.

*Figure 2*
Figure 1B - Postoperative findings show +1 IOOA and 5 PD DVD in the left eye. (Note: Approval consent for publication of the photo was attained from the patient herself)