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Research Article

The Efficacy of Anterior-Nasal Surgery in Managing Inferior Oblique Overaction either with DVD or with V Pattern

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ABSTRACT

Objective: This study aims at determining the efficacy of anterior and nasal transposition of Inferior Oblique to manage dissociated vertical deviation and vertically incomitant horizontal strabismus (V pattern).

Method: This study was both prospective and uncontrolled; it included 60 patients who suffered from inferior oblique overaction. The participants were divided into two groups: Group A had 30 patients with vertically incomitant horizontal strabismus while group B had 30 patients with dissociated vertical deviation.

Preoperative examination included: Assessment of vision, ductions and versions in the six cardinal directions of gaze and severity of IOOA graded from 0 to +4. The percentage of dissociated vertical deviation was measured using the prism under cover test in primary position.

Follow-up visits occurred in the following intervals: After one week, one month, four months, and six months respectively. In each follow-up visit, the measurements of ductions, versions, and alignment in primary position were recorded.

Results: Group A showed no pattern in 93.3% of cases postoperatively while 6.7% of cases developed insignificant V pattern (0.8 ± 2.9 ΔD), with statistically significant difference between the pre-and post-operative values (p-value<0.001). Meanwhile, group B showed a complete resolution of DVD in 100% of cases with preoperative (DVD<15 ΔD) and in 20% of cases with preoperative DVD ≥ 15 ΔD; the remaining cases had residual DVD (3.6 ± 4.1 ΔD).

Conclusion: Anterior-nasal transposition of the Inferior Oblique muscle is an effective procedure for cases with severe or recurrent inferior oblique overaction when other standard procedures of Inferior Oblique muscle fail. For DVD ≥ 15 Δ D, we recommend a combined anterior-nasal transposition of inferior oblique with superior rectus recession.

Keywords: Inferior oblique; Anterior-nasal transposition; DVD; V pattern; Vertical incomitance; Overaction; Residual DVD; Prism under cover test

INTRODUCTION

Most studies have shown that dysfunction of the oblique muscles may have a major role in the etiology of A and V patterns since inferior oblique (IO) overaction is frequently associated with V-pattern while superior oblique (SO) overaction is associated with A pattern strabismus [1]. In case of SO muscle paresis, overaction of the IO may persist even if the vertical action of the weak muscle is fully restored. The IO is an abductor, so overaction of that muscle will result in less convergent or more divergent position in the upper gaze (V-pattern) [1,2].

The anterior fibers of IO are responsible for extortion, whereas the posterior fibers are responsible for elevation. Anterior transposition of IO muscle has a mild, weakening effect on extortion; however, it markedly weakens elevation [3].

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Although there is a common association between primary IO overaction and congenital esotropia or exotropia, it can also occur as an isolated disorder without other strabismus or secondary to congenital SO palsy [4].

There is also a high prevalence rate of dissociated vertical deviation (DVD) in both essential infantile esotropia as well as infantile exotropia. DVD occurs in patients with and without overaction of IO muscle and can also be associated with SO overaction [5]. In 1997, Black used the term incomitant DVD to describe the patients who suffered from IO overaction with DVD, greater in adduction than in abduction [6].

Several surgical procedures have been adopted to manage DVD and vertically incomitant horizontal strabismus. These procedures included inferior rectus resection, bilateral superior rectus recession with placement of fixation sutures, IO recession, disinsertion, and anterior transposition [7]. Anterior and nasal transposition (ANT) of IO muscle is one of the modifications of the anterior transposition procedure [7]. This modified entails positioning the IO muscle anterior to the X-axis (vertical movement) and nasal to the Y-axis (torsional movement), and therefore converting IO from an elevator in adduction and extorter to tonic depressor in adduction and an intorter [8]. It was suggested that IO ANT is an effective procedure when other usual IO weakening procedures fail, especially for recurrent or severe IO overaction [9].

The purpose of this study, hence, was to determine the efficacy of anterior and nasal transposition of IO to manage dissociated vertical deviation (DVD) and vertically incomitant horizontal strabismus (V pattern).

METHODS

This is a prospective, uncontrolled study that included sixty patients who were halved into two groups: The first group had 30 patients with V pattern due to IO overaction, while the other group also had 30 patients with DVD with IO overaction. All patients had attended the squint clinic of the Ophthalmology Department in Fayoum University. The participants of the study were selected according to the inclusion criteria: a) the presence of manifested DVD more than 10 Δ D in one or both eyes with any level of concurrent IO muscle overaction with or without horizontal misalignment and b) the ability to cooperate with prism and alternate cover testing. The exclusion criteria included a) DVD without IO overaction, b) concurrent or previous cyclovertical muscle procedure, and c) neurological or craniofacial abnormalities. However, patients with previous or planned horizontal muscle surgeries were not excluded from the study.

We conducted the current research according to the ethical principles of the Declaration of Helsinki. It was also approved by the Research Ethical Committee of the Faculty of Medicine at Fayoum University. The patients who agreed to participate in the study signed an informed written consent after the surgical procedure had been fully explained. The intervention comprised the following phases:

Preoperative assessment

Taking the history of the cases in terms of age, symptoms, age of onset , previous treatment (spectacles, patching, and surgery), assessment of vision (with and without correction), ductions, and versions in the six cardinal directions of gaze, we graded IOOA from 0 to + 4 as follows: (0) no IOOA, (+1) mild upwards pupil deviation from the horizontal line during adduction, (+2) pupil upper margin aligned to the upper lid margin during adduction, (+3) upper half of the pupil covered by the upper lid during adduction, and (+4) the whole pupil covered by the upper lid in adduction. We then measured the percentage of DVD with full refractive correction by the prism under cover test in primary position while fixating on a target at six meters distance. A cover and base-down prism were placed over the eye with the DVD. The cover was switched to the fixating eye, and if downward movement was noticed, a larger base-down prism was used after returning the fixation to the dominant eye [7]. Angle of deviation was measured in primary position, while chin was up and then down. Ocular motility and horizontal muscles were assessed to decide whether to include any necessary surgery to correct the horizontal misalignment.

Surgical technique

We used a traction 4/0 silk suture tightly pulled across the nasal bridge and clamped to the head drape with a hemostat to keep the eye in a maximum adduction and elevation position. A conjunctival incision was made parallel to the lid margin 8 mm from the limbus, and then Tenon's capsule was incised perpendicular to the conjunctival incision, and the inferior rectus was hooked and isolated. The inferior oblique was visualized and hooked.

We ensured that there were no residual IO fibers left behind. The posterior portion of the muscle was clamped 10 mm from insertion by a hemostat and then excised. The edge of the muscle is lifted out from the wound and secured with 6/ 0 double armed vicryl suture. The muscle is reattached with its posterior-temporal fibers attached 2 mm nasal and posterior to the nasal edge of the inferior rectus insertion [9]. The new insertion was approximately 2-3 mm wide.

Postoperative assessment

Postoperative measurements were recorded after one week, six weeks, four months and six months respectively. Follow-up examination included ductions, versions, primary position alignment, upper-gaze, and lower-gaze. The success criteria of the treatment entailed normalized Inferior oblique overaction and corrected V pattern. A postoperative DVD of ≤ 5 ΔD was considered excellent while 6 ΔD – 10 ΔD was considered acceptable.

STATISTICAL ANALYSIS

We used the mean and standard deviation to reveal the change in misalignment. Also, we employed the t-test, with p-value of<0.05 considered statistically significant, to calculate the statistical significance.

RESULTS

The sixty patients who met the inclusion criteria were halved into two groups.One group had patients with vertically incomitant horizontal strabismus while the second group had patients with dissociated vertical deviation. The patients in both groups underwent an ANT IO.

As shown in Table 1, group A included 30 patients who had V pattern due to IO overaction. 22 (73.3%) patients had bilateral IO overaction while 8 (26.7%) patients had unilateral IO overaction. Eleven eyes (36.7%) were grade +4 IO overaction, while 19 eyes (63.3%) were grade +2 or +3 IO overaction.

Table 1: Preoperative data in both groups.

Item	Group A (n=30) (IO++)	Group B (n=30) (DVD and IO++)	p-value
Age mean ± SD	13.1 ± 7.3	12.4 ± 8.6	0.325
Gender M n.(%)	20 (66.7%)	12 (40%)	
F n. (%)	10 (33.3%)	18 (60%)	0.003*
ET: n.%	7 (33%)	6 (20%)	0.079
Mean ± SD	42.5 ± 3.2 Δ D	38.4 ± 2.7 Δ D	
XT: n.%	21 (70%)	15 (50%)	0.162
Mean ± SD	36 ± 4.13 Δ D	40.2 ± 1.2 Δ D	
Hypertropia n.%	2 (6.7%)	~~~~~~~~	
Mean ± SD	16.5 ± 1.2 Δ D		
DVD with no. horizontal	~~~~~	9 (30%)	
IO++ unilat.N(%)	8 (26.7%)	12 (40%)	
Bilat.N(%)	22 (73.3%)	18 (60%)	0.127
grade (range)mean ± SD	(+2/+4) 2.0 ± 0.6	(+2/+4) 2.5 ± 0.3	
V pattern mean ± SD	17.8 ± 3.9 Δ D	16.3 ± 4.7 Δ D	0.068
DVD mean ± SD	~~~~~~~~	15.8 ± 5.6 Δ D	~~~~

M: Male; F: Female; ET: Esotropia, XT: Exotropia; SD: Standard Deviation; *statistically significant p-value

Besides, 21 patients had exotropia (70% of patients); these 21 cases included 14 cases alternating XT, six cases were unilateral XT, and one case XT with hypertropia 30 ΔD. Exotropia ranged from 12 ΔD to 60 ΔD. Seven patients (23.3%) had esotropia, three of whom had alternating esotropia, while four had unilateral esotropia. Esotropia ranged from 25 ΔD to 60 ΔD. Only two cases (6.7%), had hypertropia that ranged from 18 ΔD to 15 ΔD.

The preoperative V pattern was 17.8 ± 3.9 Δ D. Twenty of patients (66.7%) had V pattern<20 ΔD (15.6 ± 1.2 Δ D). The other ten patients (33.3%) had V pattern ≥ 20 ΔD (22.3 ± 3.9 Δ D).

Twenty-six cases (86.7%) of group A were exposed to bilateral ANT IO while four cases (13.3%) underwent ANT IO in one eye. The mean follow-up period was 5.3 ± 2.4 months.

There was a remarkable improvement in the V pattern: No pattern in 28 cases (93.3%) and two cases (6.7%) developed insignificant V pattern less than 15 ΔD (their preoperative V pattern ≥ 20 ΔD). The postoperative V pattern mean was 0.8 ± 2.9 ΔD (P-value<0.001). There was a statistically significant difference between the pre and postoperative values. None of group A patients developed anti-elevation syndrome (AES), residual IO overaction, or consecutive hypotropia.

Regarding group B, which included 30 cases, 18 cases (60%) had bilateral DVD, while 12 cases (40%) had unilateral DVD. The preoperative DVD (ranged from 8 ΔD to 20 ΔD), with15 cases (50%) had DVD<15 ΔD (11 ± 2.2 ΔD), the other 15 cases (50%) had DVD ≥ 15 ΔD (20.6 ± 2.6 ΔD). Bilateral ANT IO was performed on 21 patients (70%) while unilateral ANT IO on nine patients (30%). The follow-up period was 5.5 ± 3.6 months.

By the end of the follow-up period, IO overaction disappeared in all cases of group B. The patients of group B who had DVD<15 ΔD had complete resolution of DVD (100%); for those with preoperative DVD ≥ 15 ΔD, three cases (20%) with preoperative DVD 18 ΔD had complete resolution of DVD whilethe remaining 12 cases (80%) with preoperative DVD 18-20 Δ had residual DVD = 3.6 ± 4.1 ΔD (p-value = 0 .01). There was statistically significant difference between pre and postoperative DVD of the two sub groups (those of preop DVD<15 ΔD and those of preoperative DVD ≥ 15 ΔD).

Like those of group A, none of group B patients developed AES or residual IO overaction. Table 2 illustrates the postoperative data for both groups. Additionally, Figure 1 highlights the pre- and post-operative V pattern and DVD in groups A and B respectively.

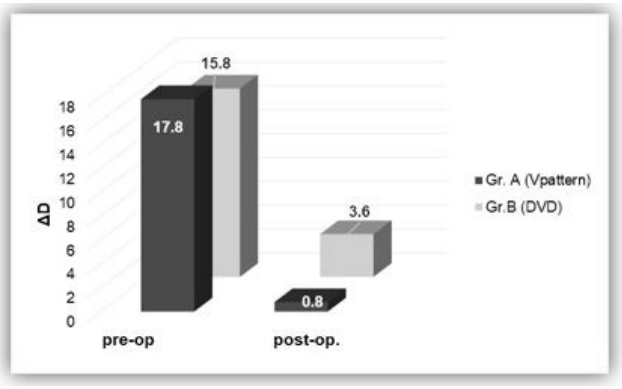

Figure 1: Pre-and post-operative V pattern and DVD in groups A and B respectively.

Table 2: Post-operative data in both groups.

Postoperative item	Group A	Group B	p-value
Unilat. Surgery n.(%)	4 (13.3%)	9 (30%)	0.324
Bilat. Surgery n.(%)	26 (86.7%)	21 (70%)	0.165
IO ++	Cured in 100%	Cured in 100%	
DVD Preop<15 Δ D		20%Cured	
Preop. ≥15 Δ D		80% had Residual(3.6 ± 4.1 Δ D)	
No V-pattern n. (%)	28 (93.3%)		
V-pattern<15 Δ D n.(%) mean ± SD	2 (6.7%)		
	0.8 ± 2.9 Δ D		
Ortho.	21 (70%)	22 (73.3%)	0.142
Residual XT	7 (23.4%)	5 (16.7%)	0.325
Residual ET	0		0.023 *
Residual HT	2 (6.6%)	3 (10%)	

XT: Exotropia; ET: Esotropia; HT: Hypertropia; *: statistically significant p-value

Complications

Three out of the nine cases who underwent unilateral ANT IO in group B developed contralateral DVD.

DISCUSSION

In cases with large DVD, anterior transposition of IO may yield less effective outcomes; for instance, Engman and his team achieved desirable outcome in only 25% of patients with DVD >15 Δ D [10]. This was the case in our study as we had excellent outcomes in only 20% of patients with DVD ≥ 15D, suggesting that Stager's method is also less effective for large DVD angle, or in other word may need to be augmented with additional procedure.

In 2001, Stager suggested that anterior and nasal transposition of inferior oblique muscle (ANTIO) decreases the risk of AES by making the IO muscle an intorter and depressor instead of an extorter and elevator in adduction [8]. Subsequently, in 2009, Awadein recorded that IO overaction completely disappeared in 80% of cases after ANT with no significant under-or over-correction. Only 20% of his cases had consecutive IO underaction on both sides. He also found that there was marked improvement in the symmetry of eye versions and IO overaction after performing the surgery on patients with either preoperative esotropia or exotropia [11]. Our findings are in line with those of Awadein as we recorded postoperative mild IO underaction in all cases that improved by the end of follow-up period. There was also noticeable improvement in symmetry of eye version; besides, inferior oblique muscle overaction disappeared by the end of follow-up period in all cases.

In the current study, there was complete improvement in V pattern in 93.3% of patients, while two cases (6.7%)who had preoperative V pattern 20 ΔD developed insignificant V pattern <15 ΔD. No case with postoperative AES was recorded. Such findings coincide with those of Fard (2010) who recorded complete improvement of V pattern in 80% of cases. He did not record any case with AES as well [7].

In 2016, Farid compared ANT with AT of IO in DVD cases. He found that there was 100% resolution of DVD in patients with small degrees [12]. Our findings are aligned with his as we recorded complete resolution of DVD (100%) in patients with preoperative DVD<15 ΔD.

In Fard's study, which included 10 patients 40% of operated eyes developed a postoperative hypotropia ranging from 2 Δ D to 5 Δ D while 15% developed elevation deficiency. In ours, however, no patient developed consecutive hypotropia, residual IO overaction, or AES even in unilateral ANT IO. The discrepancy between our findings and that of Fard's can be explained through the great asymmetry of high DVD that was >15 ΔD in 17 eyes which presented 85% of total eyes in his study [7]compared to 50% of total DVD cases in our study. These results support our findings that the stager's technique alone is less effective in cases with higher DVD angle (i.e>15 ΔD)

CONCLUSION

ANT of the IO muscle is a more likely effective procedure to lessen and reverse the action of the IO in cases with severe or recurrent IO overaction, especially when other IO muscle usual procedures fail. We recommend this surgery for patients with V pattern >20 Δ D, DVD < 15 Δ D, or a higher risk of developing dissociated vertical deviation. For patients with DVD ≥ 15 Δ D, we recommend combined ANT IO surgery with SR recession.

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