Temporal Versus Nasal Anterior Transposition of the Inferior Oblique Muscle for Management of Dissociated Vertical Deviation with Inferior Oblique over Action

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Abstract: **Purpose:** Comparative study of anterior temporal transposition (ATIO) of the inferior oblique muscles versus anterior nasal transposition (ANT) in management dissociated vertical deviation (DVD) with inferior oblique muscle overaction (IOOA).

Methods: The study carried out on 40 eyes of 23 patients with DVD of at least 10 prism dioptres PD in the eye involved. The patients divided into two groups. Group I (20 eyes of 12 patients) managed by anterior temporal transposition (ATIO) of the inferior oblique muscles and Group II (20 eyes of 11patients) managed by anterior nasal transposition (ANT) of the inferior oblique muscles. All patients were followed for at least 6 months postoperatively. The size of preoperative and postoperative DVD, grade of the preoperative and postoperative IOOA, repeat surgeries and complications are recorded and evaluated.

Results: In group I the mean DVD was decreased in primary positions from 21.1±4.3 PD to 9.5 ±4.7 (P<0.001) and from 19.4±4.5 PD to 5.5 ±2.6 (P<0.001) in group II. Mean IOOA was decreased from +2.0 ±0.7 to +0.18±0.4 in group I (P<0.001) and from +2.5 ±0.7 to +0.1±0.5 (P<0.001) in group II. In group II, two patients developed hypotropia of 5 and 6 PD. Persistent IOOA (+1) was observed postoperatively in two eyes in each group. Limited elevations in abduction developed in 3 patients in group I.

Conclusion: Anterior transpositions of the inferior oblique muscles either temporal or nasal are effective for DVD treatment with inferior oblique muscle overaction. Anterior nasal transposition (ANT) is more statistically significant in correction DVD with less incidence of antielevation syndrome and recurrence of DVD. However, ANT may induce hypotropia.

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Keyword: DVD, IOOA, ATIO and ANT.

1. Introduction

Dissociated vertical deviation (DVD) is characterised by elevation, abduction and excyclotorsion of the nonfixing eye without corresponding hypotropia in the other eye. It is demonstrated by upward drifting and outward movement of the occluded eye on cover testing.[1] DVD is usually, but not always, bilateral but asymmetrical. In addition to DVD, inferior oblique overaction (IOOA) is also responsible for excessive elevation of one or both eyes but only in adduction.[2] several different procedures have been used with varying success to surgically manage DVD. In the past, bilateral large (symmetrical or asymmetrical) inferior rectus resections were advocated but, in recent years, this procedure has been abandoned by many surgeons.[3,4] currently, two methods have been preferred, particularly when both DVD and IOOA are present, and these are anterior transposition of the inferior oblique muscle (ATIO) and myectomy of the inferior oblique muscle (MIO). [5,6,7] Anterior nasal transposition (ANT) is a relatively new procedure,[8,9,11] in which the insertion is transposed to a location over the nasal half of the inferior rectus muscle typically 2 mm nasal to the nasal border of the inferior rectus muscle and 2 mm posterior to the inferior rectus insertion). The inferior oblique is thus transformed from an extorter into an intorter and from an elevator to a depressor. The ANT can be used to eliminate or reduce severe excyclotorsion. An advantage of this procedure over temporal anterior transposition is that it avoids Ante-elevation syndrome.[9,10] Good outcomes have also been reported in cases of overelevation in adduction combined with DVD. This success is likely due to the fact that the ANT procedure makes the inferior oblique muscle into a tonic depressor. [11]

The objective of this study was to compare the results of anterior temporal transposition (ATIO) in comparison to anterior nasal transposition (ANT) of the inferior oblique muscle in patients who had DVD with IOOA.

2. Materials and Methods

PATIENTS

This study includes 40 eyes of 23 patients with DVD of 10 or more prism dioptres (PD) in one or

both eyes with IOOA that required surgery the selection criteria for inclusion in the study were the patients with manifest or latent DVD, with concomitant IOOA. The patients who had paretic or restrictive strabismus, any prior surgery for the oblique muscle, vertical rectus muscle or concurrent vertical off-setting of the horizontal rectus muscles as well as patients with any systemic disorder or syndrome that might have affected extraocular muscles were not included. The patients divided into two groups according to the procedure. Group I (20 eyes of 12 patients managed by temporal anterior transposition (ATIO) and Group II (20 eyes of 11 patients) managed by nasal anterior transposition.

DVD was measured by the method described by *Burke et al.*[16], using a prism and an alternate covering test in which the eyes, in primary position, are fixed at an adjustable target at a distance of 6 m and have full refractive corrections, when these are worn any concurrent horizontal deviation was neutralized using a horizontal prism. Subsequently, DVD in the other eye was measured in the same way. We evaluated any true hypertropia in primary eye position and in side gazes to distinguish between IOOA and DVD Oblique muscle function was estimated on a grading scale of 1+ to 4+ (overaction) based on eye movements in an upward, a downward and a side gaze. Grade 1+ represented 1 mm of higher elevation of the adducting eye in gaze up and to the side. Grade 4+ indicated 4 mm of higher elevation.

Surgical Treatment

All surgeries were done by the author. The inferior oblique muscle was approached through the conjunctiva and Tenon's capsule by an inferior-temporal fornix incision. During the procedure, the lateral rectus muscle was isolated by a muscle hook. The inferior oblique muscle is exposed by placing a small Steven's hook along the inferior border of the lateral rectus muscle and a large Von Graefe hook is placed directly against sclera to be inserted posteriorly under the inferior oblique muscle. The Von Graefe hook is properly positioned perpendicular to the inferior oblique muscle fibers under the entire width of the inferior oblique muscle. Raising the hook allows visualization of the area between the inferior oblique and sclera. Once the posterior border of the inferior oblique is identified by direct visualization, a Steven's hook is placed behind the posterior border. The inferior oblique muscle was isolated from its fascial attachments both anteriorly and posteriorly. A 6–0, suture (Vicryl) was passed through the muscle in group A and 5-0 Mersiline (Non-absorbable) suture in group II to avoid retraction and slippage of new muscle insertion as recommended by Stager *et al.*[9] The inferior oblique muscle has been secured with a double-arm suture and is being disinserted with the blunt Westcott scissors. After the inferior oblique muscle is disinserted, the muscle is reattached to the sclera. In temporal procedure reattached through sclera by using the crossed-swords technique so that the new insertion lay lateral to and collinear with the inferior rectus muscle insertion in nasal procedure the posterior–temporal fibers attached 2 mm nasal and2mm posterior to the nasal extent of the inferior rectus muscle insertion. The new insertion is not spread out, and its width was approximately 2mm to 3mm.

The inferior oblique muscle was then inspected to ensure that no residual fibers remained that had not been anteriorly transposed. The conjunctiva was closed with 6–0 (Vicryl) suture. Post-operative follow up were recorded at 1, 3, and 6 months. At last post-operative visit, DVD of 0–9 PD was considered a good result and 10–14 PD a fair result.

Statistical Analysis:

The results were evaluated and analyzed using the computer program SPSS (IBM Corp, Armonk, NY, USA). Statistical significance was tested using paired *t*-test and willcoxon test with *P*-value <0.05 was considered statistically significant.

3. Results

In the group I (12 patients of 20 eyes) the patients ages ranged from 7 to 30 years mean was 21.6 with standard deviation of± 4.6. Sven patients was female (58%) and 6 patients was male (42%). Eight patients had bilateral DVD. Preoperatively DVD angle measuring between 10 and 25Δ (mean, 21.1±4.3 PD) 14 eyes had DVD ≤ 15Δ (70 %), the remaining had DVD> 15Δ (30%).

In the group II (11 patients of 20 eyes) the patients ages ranged from 9 to 31 years mean was 15.3 with standard deviation of ±3.8. Seven patients was female (63%) and 4 patients was male (47%). Nine patients had bilateral DVD (81%) Preoperatively DVD angle measuring between 10 and 25Δ (mean, 19.4±4.5), 11 eyes had DVD ≤ 15Δ (65 %), the remaining had DVD> 15Δ(35%) postoperatively DVD angle measured between 0 and 5Δ (mean 1.17Δ). Mean follow-up was 8.4±2.3 months for group I and 9.4±3.2 months for group II.

All patients in both groups had preoperative inferior oblique overaction. Mean pre - and post-operative IOOA in both groups are shown in table 1. In both groups, improvement of IOOA was statistically significant (P<0.001) although difference between both groups was statistically insignificant (P≥0.05). Persistent IOOA (+1) was observed postoperatively in two eyes in each group. In ANT group, two patients, was developed post-operative IO underaction (−1).

Table 1. Grading of IOOA in both groups.

Grading of IOOA	Group I	Group II
+2-+3	13 Eyes 59%	12 Eyes 53%
+4	7 Eyes 41%	8 Eyes 47%
IOOA: inferior oblique overaction. +2 represented 2 mm of higher elevation of the adducting eye in gaze up and to the side. Grade +4 indicated 4 mm of higher elevation.		

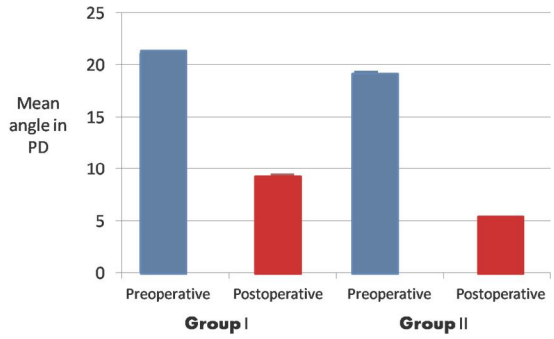
In group I, ATIO was done isolated in seven patients, combined with horizontal muscle surgery in four patients. Three patients who underwent combined ATIO and horizontal muscle surgery were esotropic. They underwent ATIO combined with bimedial rectus recession (average 5.5±0.5 mm), which resulted in improveme preoperati patient un rectus re improveme to 5 PD.

In gr patients, w patients horizontal esotropic 38.6±5.9 I ANT com 5.9±0.5 mr

resulted in an average post-operative deviation of 5±.9 PD ET The exotropic patients underwent combined ANT with (average 6.5±0.5 mm) mm bilateral lateral rectus recession that resulted in 10 PD XT postoperatively.

In both groups preoperatively, two patients, one in each group had no fusion with worth's four dot test. All other patients had different grades of stereopsis 'ranging from 40 to 800 arcsec'.

Assessment of postoperative deviation in terms of the mean value of prism dioptres showed that the surgical technique were successful because the differences between pre- and postoperative values were significant Figure (2).



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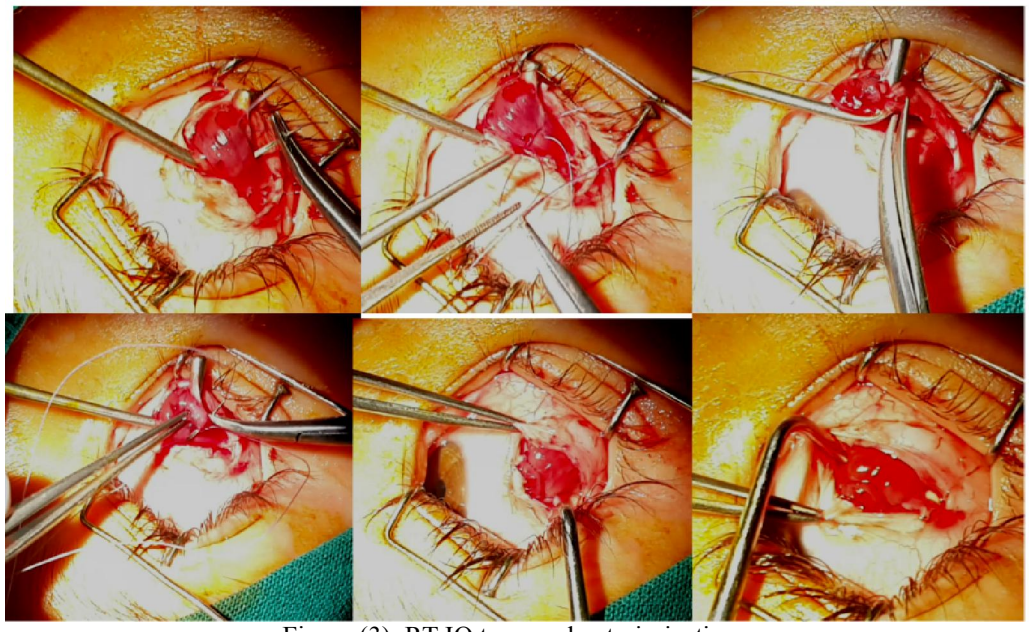

Figure (3): RT IO temporal anteriorization.

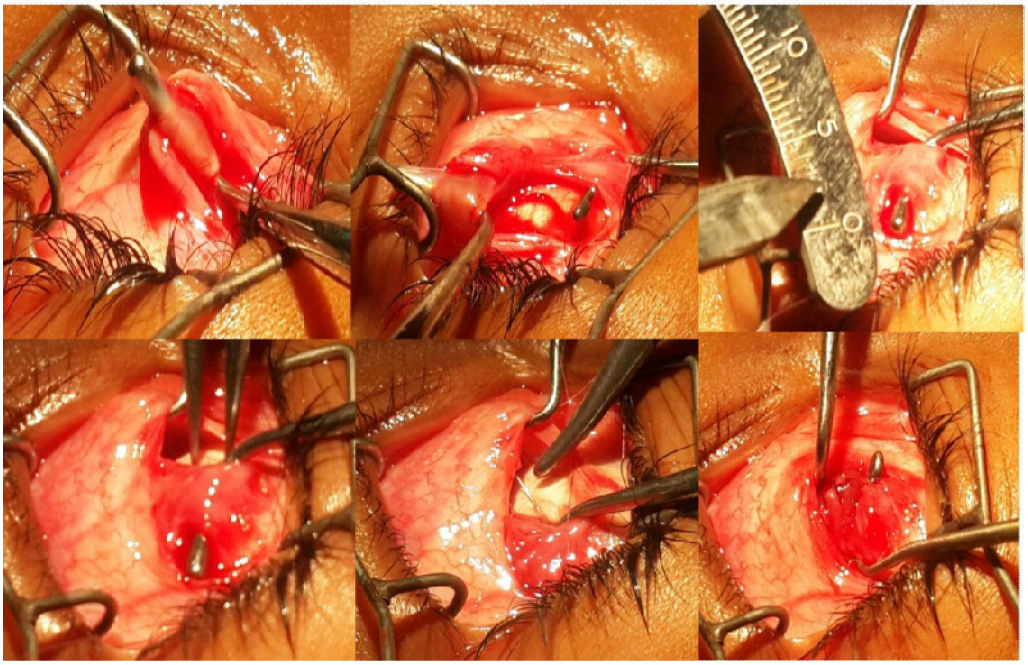

Figure (4): RT IO nasal anteriorization.

In group I before the operation, DVD in primary position averaged 21.1±4.3 PD (10–25 PD), 26.35±4.3 PD (18–32 PD) in adduction, and 5.5±2.02 PD (4–7 PD) in abduction. After the operation, DVD averaged 9.5±3.79 PD (5–15 PD) in primary position (P<0.001), 4.8±1.94 PD (2–7 PD) in adduction (P<0.001), and 3.16±1.09 PD (0–5 PD) in abduction (P>0.05).

In group II DVD averaged 19.4±4.5 PD (10–25 PD) in primary position, 27.7±5.3 PD (19–34 PD) in adduction, and 3.5±1.1 PD (2–5 PD) in abduction. After the operation, DVD averaged 5.9±1.19 PD (2–6 PD) in primary position (P<0.001), 5.1±1.5 PD (4–8 PD) in adduction (P<0.001), and 1.40±1.2 PD (1–3 PD) in abduction (P<0.001).

In-group II correction in primary position and in abduction, which is statistically significant (P≤0.05) while in adduction, there is insignificant difference in correction of DVD among both groups (P>0.05).

In group II, two patients developed hypotropia of 5 and 6 PD. Limited elevations in abduction developed after surgery in 3 patients in group I.

4. Discussion

Several authors have evaluated the effectiveness of anteriorization of the inferior oblique muscle (ATIO) for management of DVD with IOOA[11]-[13] these studies have shown that (ATIO) is effective in controlling DVD in the majority of cases and more effective in treatment of DVD in the presence of IOOA. The present study was designed to compare the results of anterior temporal transposition versus anterior nasal transposition of the inferior oblique muscle in patients who had DVD with IOOA.

In this study good outcomes were achieved by both methods in treating IOOA. Persistent IOOA (+1) was observed postoperatively in two eyes in each group after 6 months. Postoperatively three eyes in group I and four eyes in group II presented by IO underaction ranged from grade -1 to -3 in first postoperative visits. All cases had IO underaction improved along follow up period (100% of patients). There was marked improvement in symmetry of eye version and IO overaction at 6 month.

Mims and Woods claimed that ATIO changes IO action from an elevator to a depressor due to Lockwood's ligament effect.[14] Elliot and Nankin[15] compared ATIO to IO recession in treating IOOA and concluded that ATIO changes the action of IO from an elevator to a depressor. Mims and Woods[14] noted improvement in DVD and IOOA when evaluating bilateral ATIO in treatment of 61 IOOA patients. Burke *et al*[16] found that ATIO was effective in controlling DVD in 19 out of 22 eyes.

In group I anterior temporal transposition of IO improved vertical devotion up to 20 PD in primary position. Two cases developed residual vertical deviation 10 PD (preoperative 25-3 PD), which need superior rectus recession.

Guemes, [19] suggested that unilateral anterior transposition procedure resulted in a mean reduction in the vertical deviation of 18 PD. Weakening of the inferior oblique muscle produces 5 to 10 PD reduction in hyperdeviation in the primary position and up to 20

PD reduction in hyperdeviation in the field of action of this muscle. Unilateral anterior temporal transposition of IO had been done in four cases in group I, two cases developed contralateral DVD.

In the current study in group I, Preoperative DVD ≤15 PD had xcellent outcome (0-5PD). Black[17]and Engman[18] reported excellent results of ATIO in 56% of cases with small DVD and in 25% of cases with large DVD (>15 PD). Milot *et al*[20] concluded that ATIO is more effective in eliminating IOOA (100% of cases) but the procedure is less predictable for DVD with 29.4% recurrences during a follow-up period of 28.2 months. Coats[21] results also were less encouraging regarding ATIO in treatment of DVD.

Limited elevation in abduction developed after surgery in 3 patients in group I. *Kushner*[12] has shown that the limited elevation in abduction, a complication of ATIO, occurs when the transposition of the inferior oblique muscle anterior to the inferior rectus muscle insertion is greater than 1 mm[12]. This complication, which results in either a Y or V pattern, is more likely to happen if the inferior oblique insertion is spread out when being reattached to the globe. ATIO converts the posterior fibers of that muscle segment to a tonic depressor in the primary position and an anti elevator limiting up gaze to 30–35°.[13,14] After ATIO, the normal increased innervations of the IO muscle on supraduction produces a powerful force vector directed inferiorly, effect termed antielevating.[15] This antielevating force can produce overaction of the contralateral elevators in adduction that mimics recurrent or new overaction of the IO muscle of the other eye.[16,17]

In group II ANT IO improved vertical deviation up to 20Δ in primary position. Two cases developed residual vertical deviation 10Δ(preoperative 25-30Δ). Awadein [22], suggested that IO overaction after ANT disappeared completely in 80%with no significant under-or over-correction. 20% of patients had consecutive IO underaction on both sides.

Stager et al[8] in 2001 proposed transposing IO not only anteriorly but also nasally to the nasal border of IR. In this technique, the IO is positioned anterior to *x* axis and nasal to *y* axis, which changes IO from an elevator and extorter to a depressor and intorter in adduction. Furthermore, in 2003, they studied the effect of this new procedure on IOOA in a diverse group of patients. Among them, two cases had DVD associated and ANT resulted in elimination of both. Fard[11] concluded that ANT was effective in controlling DVD, IOOA, and V pattern in his 10 patient's study with 53% of his patients with large DVD achieved an excellent outcome and 47% had a fair outcome. In group II of the current study, only 35% of patients with DVD>15 PD achieved an excellent outcome and 62.5% had a good outcome. Our ANT results exactly match that of Fard study in small DVD patients where 100% of patients achieved an excellent outcome.

Standard anterior transposition of the inferior oblique muscles may also less effective in patients with larger amounts of DVD. ANTIO resulted in excellent outcome (residual DVD of 0-5 PD) in 60% of patients, up to 53% of eyes with DVD of 15 PD or more For patients who had 0 to 15 PD of preoperative DVD, 100% had an excellent outcome.

Stager et al, [9] Proved that ANT procedure was performed with success both unilaterally or bilaterally. In the patients who underwent unilateral ANT, no specific problems in up gaze.

To compare the results of ATIO and ANT for management of DVD with IOOA. Generally, both procedures are almost equally effective in controlling IOOA, hypertropia and DVD. ANT gives significantly better results for DVD in primary position and in abduction but less likely to develop antielevation, consecutive hypotropia and persistent IO under action.

In conclusion

The comparison of two surgical methods for treating DVD with IOOA showed that both procedures were effective in correcting dissociated vertical deviation and inferior oblique muscle overaction, but nasal transposition of the inferior oblique muscle is a more potent surgery with greater improvement in the degree of inferior oblique overaction and less likely to develop antielevation, consecutive hypotropia and persistent IO under action.

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