

# Anterior and Nasal Transposition of the Inferior Oblique Muscle in Patients with the Inferior Oblique Muscle Overaction

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## Abstract

**Purpose:** To evaluate the results of anterior and nasal transposition (ANT) of the inferior oblique muscle (IO) in patients with the IO muscle overaction

**Methods:** This retrospective case series included patients with IO muscles overaction, in whom ANT of the IO muscle was performed. In patient with simultaneous horizontal deviation, horizontal strabismus surgery was also performed. They were evaluated pre- and post-operatively for alignment and oculomotor examination.

**Results:** Seven patients with the mean age of  $9.2 \pm 5.2$  years were included for the study. Unilateral and bilateral ANT was performed in one and 6 patients respectively. Patients were followed for a mean of  $32.5 \pm 9$  months. IO muscle overaction was eliminated in all patients. Antielevation syndrome was developed in 2 patients. One patient needed further operation for residual horizontal deviation.

**Conclusion:** It seems that ANT is useful for the treatment of patients with the IO overaction. However, the risk of antielevation syndrome should be considered.

**Keywords:** inferior oblique muscle overaction, anterior transposition of inferior oblique muscle, antielevation syndrome

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## Introduction

Anterior transposition of the inferior oblique muscle (ATIO) was first reported by Elliott and Nankin<sup>1</sup> who found that the anterior transposition was an effective way to reduce inferior oblique (IO) muscle overaction. They described an ATIO procedure which was designed to bring the insertion closer to the frontal plane containing the origin of the IO to enhance the weakening effect. Mims<sup>2</sup> found that the procedure eliminated the need for dissociated vertical deviation surgery in the

vast majority of cases. Thus, a technique of correcting both IO overaction and dissociated vertical deviation could be accomplished with one muscle procedure in each eye.

Although no post - ANT antielevation syndrome (AES) was reported in the Stager's series, we found patients developed AES after ANT procedure. In this study we report the results of ANT procedure in the management of 7 patients with IO muscle overaction.

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After ATIO, the normal increased innervation of the IO muscle on supraduction produces a powerful force vector directed inferiorly, an effect Kushner<sup>3</sup> termed “antielevating”. 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. This phenomenon may be termed the AES.

To decrease the incidence of AES, several modifications of ATIO based on the new insertion of IO muscle were developed. Mims and Wood,<sup>4</sup> determined that the incidence of AES diminished when the temporal fibers were placed just anterior to the lateral border of the inferior rectus muscle (IR) insertion. Stager<sup>5</sup> suggested that placing new IO muscle, even further nasally and just anterior to the midportion or the nasal half of the IR muscle insertion, decreases the risk of AES even more. In a modified technique for reducing AES, Stager et al<sup>6</sup> reported successful treatment of IO muscle overaction using anterior and nasal transposition (ANT) of the IO muscle.

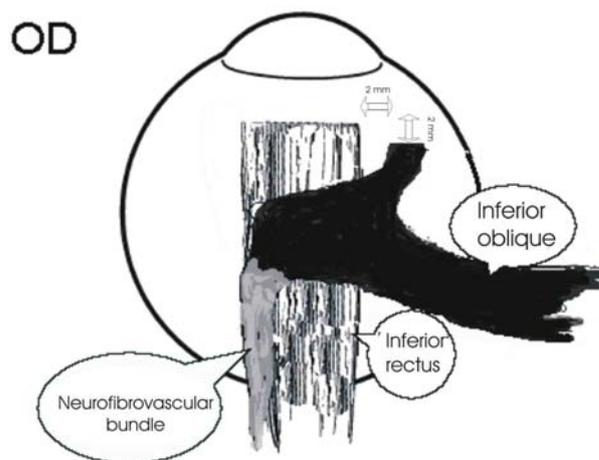
In this study, we report the results of this procedure in the management of 7 patients with IO muscle overaction.

## Methods

A retrospective chart review was conducted on all of the authors' patients, in whom ANT was performed from August 2003 to April 2004. Patients with IO muscle overaction who underwent ANT procedure included in the study. Exclusion criteria were any craniofacial malformation affecting ocular alignment and the history of any previous ocular surgery. Patients' data including age, diagnosis, preoperative and postoperative oculomotor and alignment examinations, and the length of follow-up time were recorded.

The technique of the anterior and nasal transposition was described elsewhere.<sup>6</sup> Briefly, similar to the procedure for anterior transposition of the IO muscle, the lateral rectus muscle was isolated with a muscle hook and the eye rotated nasally and superiorly. After isolating the IO muscle with a muscle hook, it was disinserted and reattached to the sclera with the posterior-temporal fibers attached typically 2 mm nasal and 2 mm posterior to the nasal extent of the IR muscle insertion applying

absorbable (6-0 polyglactin 910) sutures (Figure 1). In patients with significant horizontal deviation in the primary position (more than 20 diopters), concurrent horizontal strabismus surgery (recession of either both medial rectus muscles for esodeviation or lateral rectus muscles for exodeviation) was performed.



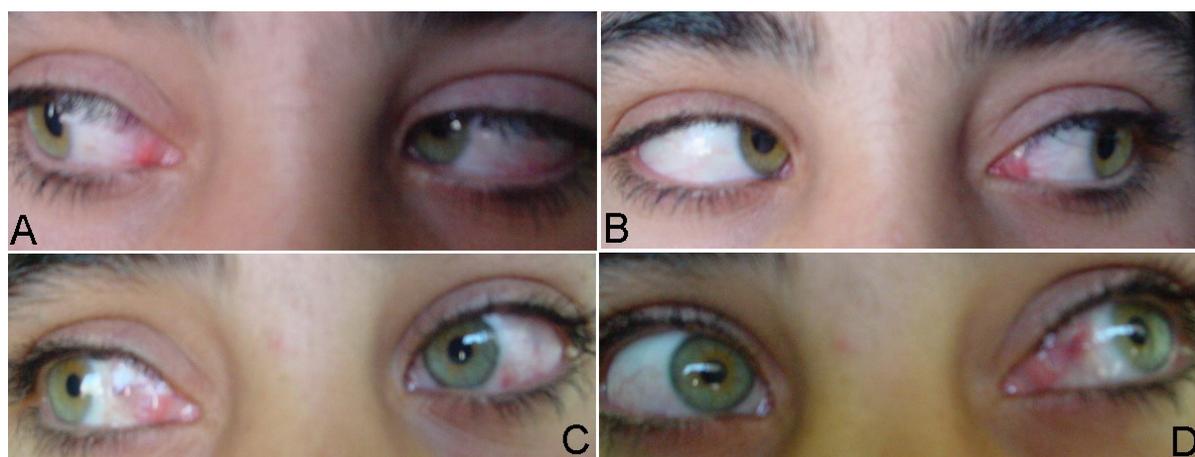
**Figure 1.** Right eye, viewed from below. Schematic representation of the IO muscle in its new position after anterior and nasal transposition, 2 mm nasal and 2 mm posterior to the insertion of the IR.

## Results

Seven patients with IO muscle overaction ranging in age from 2 to 17 years (mean  $9.2 \pm 5.2$  years) underwent ANT of the IO muscle. Patients' demographics have been summarized in table 1. Mean follow-up time was  $32.5 \pm 9$  months (ranged 24-48 months). The anterior and nasal transposition procedure was performed unilaterally in one (14.3%) and bilaterally in 6 patients (85.7%).

In all patients, ANT resulted in the elimination of IO muscle overaction in adduction. Furthermore, in patients with superior oblique muscle palsy, head tilt, torsion and hypertropia in primary position were eliminated. Limitation of elevation in abduction (Figure 2) was developed in 2 patients (28.5%).

The deviation in the primary position was eliminated or substantially improved in 6 patients (85.7%), whereas one patient needed further operation for the residual horizontal deviation.



**Figur e 2.** Preoperative (A and B) and one week postoperative (C and D) versions in a subject with inferior oblique muscle overaction (right more than left) associated with congenital esotropia who underwent bilateral anterior and nasal transposition procedure concurrent with bilateral medial rectus muscle recession. Limitation of elevation in abduction (antielevation syndrome) is readily seen in right and upgaze (C).

**Table 1.** Pre- and post-operative data of patients underwent anterior and nasal transposition of the inferior oblique muscle

No.	Age (years)	Diagnosis	Preoperative alignment in primary position (prism diopters)	Other significant findings	Follow-up (months)	Alignment in primary position (prism diopters) and IOO on last examination	comments
1	8	Bilateral primary IOO	40 ET	V pattern	24	Orthotropia	
2	17	Bilateral primary IOO	70 ET	V pattern	36	Orthotropia	
3	7	Bilateral primary IOO	35 ET	V pattern	36	Orthotropia	
4	13	Bilateral primary IOO	30 ET	V pattern	24	Orthotropia	Mild right AES
5	2	Bilateral primary IOO	40 ET	DVD	36	20 Residual ET	operation for residual ET
6	13	Unilateral SO palsy	35 RHT	No	24	Orthotropia	Mild right AES
7	5	Bilateral primary IOO	40 XT	V pattern	48	10 consecutive XT	

IOO: Inferior oblique overaction  
 ET: Esotropia  
 XT: Exotropia  
 DVD: Dissociated vertical deviation  
 AES: Antielevation syndrome  
 SO: Superior oblique  
 RHT: Right hypertropia

## Discussion

The action of IO muscle in the primary position is extorsion and elevation. Overaction of IO muscle is characterized by increased elevation in adduction. With overaction, an upshot and splaying outward (divergence) of the adducting eye are present on attempted

elevation in side gaze. This creates a Y or V pattern.

IO weakening procedures include recession, myotomy, myectomy, anterior transposition, nasal transposition, denervation, and extirpation.<sup>1,2,5,7-9</sup> Furthermore, these

procedures may have some complications such as persistent overaction, marked underaction, limitation of upgaze, antielevation syndrome, subsequent overaction of the IO muscle of the opposite eye, Y-pattern exotropia in upgaze, incyclotorsion, changes in eyelid position, esotropia in upgaze, and distortion of the inferior rectus muscle.<sup>7</sup> Recurrent IO muscle overaction (overelevation in adduction) is common and it ranges from 15% to 100%, depending on the type of surgery.<sup>7</sup>

ATIO changes the relation of the muscle with the Axes of Fick increasing abduction and excyclotorsion particularly when the muscle contracts in upgaze. ATIO converts the posterior fibers of that muscle segment to a tonic depressor in the primary position and an antielevator limiting upgaze to 30–35°.<sup>6,9</sup>

Anterior and nasal transposition is a relatively new procedure that has been devised to weaken the IO muscle.<sup>6</sup> The procedure places the insertion of the IO muscle on the nasal side of the IR muscle and, hence, nasal to the y-axis and anterior to the x-axis of Fick. This should convert the muscle into an antielevator and an intorter in adduction instead of being an elevator and extorter in adduction.<sup>5,6</sup> Theoretically, ANT results in the elimination of overelevation in adduction and helps to eliminate or to reduce the eyes divergence in upgaze.<sup>6</sup>

Stager et al<sup>6</sup> reported subjects with overelevation in adduction who underwent nasal anteriorization of the IO muscle. They placed the new insertion of IO with various distance (0-4 mm) from IR insertion. Overelevation in adduction was eliminated in 55% and improved in remaining subjects. Although a large improvement was found in ocular alignment, extorsion, and head posture in most patients, a poor result was noted in a patient with Y pattern exotropia. Their study revealed the risk of limitation to elevation, incyclotorsion and esotropia in upgaze, and distortion of the IR muscle by pulling on the fibrovascular bundle so far nasally. However, AES was not reported as a complication of their procedures.

In a more recent report, Hussein et al<sup>10</sup> evaluated nine children with unilateral or bilateral absent superior oblique tendons who underwent ANT of the IO muscles, some in combination with horizontal rectus recession

for horizontal strabismus. Postoperatively, all patients improved. Unilateral cases were orthotropic with no abnormal head posture. In the bilateral cases, vertical deviation in adduction and exotropia in upgaze had largely cleared, although some symptoms remained most notably in vertical deviation in side gaze and V-pattern esotropia in downgaze. They did not report AES in their subjects.

In our series, ANT resulted in the elimination of overaction of IO in adduction as well as the elimination of head tilt, torsion, and hypertropia in primary position.

No patient in our study showed residual IO overaction; however, limitation of elevation in abduction (AES) was observed in 2 patients. Although our results in the improvement of alignment and torsion is similar to those of Stager et al<sup>6</sup> and Hussein et al,<sup>10</sup> AES development in our patients is a differentiating finding.

Kushner<sup>3</sup> explained an abnormal motility pattern which was observed in some patients after bilateral ATIO. This pattern resembles marked recurrent IO overaction associated with a Y or V pattern and exotropia in upgaze. Small alternating hypertropias (right hypertropia in left gaze and left hypertropia in right gaze) may be present in far side gazes, but these hypertropias are much smaller than those seen in cases of primary IO overaction with a similar appearance on version testing. A limitation of elevation of the abducting eye is frequently demonstrable. Kushner has hypothesized that this complication of ATIO is produced primarily by the posterior fibers of the IO muscle. Mims and Wood<sup>4</sup> proposed that AES may be prevented by attaching the posterior fibers of the anteriorized IO muscle no more than 2 mm lateral to the IR muscle insertion. Stager et al<sup>6</sup> hypothesized that nasal anterior transposition of the IO muscle by superimposing the functional origin of IO with the Y and Z axes of Fick, may be more able to decrease the occurrence rate of this phenomenon. To our knowledge, our study is the first report of AES after ANT and shows that the development of AES can not be prevented completely by ANT procedure.

Our study has some limitations. Small number and heterogeneity of patients and the absence of control group limits the power of the study to draw a definitive conclusion. We recommend larger studies with matched

control groups and with different techniques of IO weakening.

### **Conclusion**

Although ANT procedure may be effective to weaken the IO muscle, it should not be

replaced with the current proven surgical techniques. Until the large trials establish the safety and efficacy of this technique, it should be reserved for cases in which the other IO weakening procedures have been failed or are deemed destined to fail.

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