Underacting Inferior Oblique Muscle Following Myectomy or Recession for Unilateral Inferior Oblique Overaction

Sudipto Bhatta, MRCOphth; Graham Auger, MBBS; Tsiang Ung, MRCOphth; John Burke, FRCS, FRCOphth

ABSTRACT

Purpose: To assess the incidence and investigate the functional impact of postoperative overcorrection following primary unilateral inferior oblique muscle recession and myectomy for inferior oblique overaction.

Methods: A retrospective study of 79 consecutive patients undergoing inferior oblique myectomy (43) or recession (36) with a minimum 6 months of postoperative follow-up. All underwent ocular motility examinations preoperatively and postoperatively at approximately 2 weeks and 6 months. The vertical deviation in primary position and on contralateral gaze and inferior oblique versions and ductions on contralateral elevation were analyzed.

Results: At 6 months, 51 patients had no inferior oblique underaction (group 1), 23 of 28 who had developed inferior oblique underaction were asymptomatic (group 2), and the remaining 5 were symptomatic (group 3). The mean preoperative hyperdeviation was 12.9 (group 1), 13.1 (group 2), and 15 (group 3) prism diopters (PD) in primary position. Postoperatively, these measured 3.8 (group 1), 3.8 (group 2), and -7.8 (group 3) PD (- indicates deviation reversal). The mean preoperative and postoperative inferior oblique versions for these three groups were +2.7, +2.2, +2.2 units and +0.9, -1.0, -1.4 units, respectively.

Conclusion: Inferior oblique underaction was common (28 patients, 35.4%), generally mild, persistent, and usually asymptomatic 6 months following surgery. Although uncommon (5 patients, 6.3%), symptomatic inferior oblique underaction required further surgery with a successful outcome. They included 2 patients with a history of head or orbital trauma and one with masked and one with highly asymmetric bilateral inferior oblique overaction.

INTRODUCTION

The evolution of inferior oblique weakening procedures temporal to the inferior rectus muscle has continued since White and Brown reported inferior oblique disinsertion in the 1930s.1 Currently, inferior oblique myectomy temporal to the inferior rectus muscle and graded inferior oblique recession are arguably the most popular procedures employed to treat inferior oblique overaction.2-5 In a prospective study, both were similarly effective in managing the overacting inferior oblique muscle.6 Other retrospective studies have reported postoperative inferior oblique overaction rates of only 1.7% to 5.0% following myectomy,5,7 whereas apparent contralateral...
inferior oblique muscle overaction in the fellow eye following a unilateral inferior oblique muscle recession has also been described. The functional impact and incidence of inferior oblique underaction following these two operations have not been specifically highlighted in the literature. This is in contrast to a postoperative reduction in elevation, especially in abduction following inferior oblique anterior transposition, and the documented risk of inducing a postoperative primary position deviation reversal that can be symptomatic.

This study specifically evaluated the incidence, behavior, and functional impact of postoperative inferior oblique underaction following unilateral inferior oblique myectomy or recession.

PATIENTS AND METHODS

We defined postoperative underaction of the inferior oblique muscle as reversal of the vertical deviation at least in the maximal field of inferior oblique muscle action, namely contralateral up gaze as documented by alternate cover and prism test and ocular movements with or without deviation reversal in primary position and on contralateral versions. The etiology of the inferior oblique overaction was taken from the medical records.

Patients who had no previous strabismus surgery with unilateral or markedly asymmetric bilateral inferior oblique overaction (> 2.0 units difference) or inferior oblique overaction secondary to superior oblique underaction and a primary position hyperdeviation underwent unilateral inferior oblique recession or myectomy by a single surgeon (JB) over a 10-year period and derived from a surgical logbook were included. None of these patients underwent simultaneous horizontal muscle surgery. The follow-up data were analyzed at approximately 2 weeks and 6 months after initial surgery. Both inferior oblique weakening procedures were routinely performed in our postgraduate teaching institution. There was no clinical bias to the weakening procedure selected with the exception of patients with a preoperative +4 inferior oblique overaction, where there may have been a bias to perform inferior oblique myectomy because 4 of 5 of these patients underwent myectomy and 1 of 5 a recession procedure.

An ocular motility assessment was performed on all patients preoperatively and approximately 2 weeks and 6 months postoperatively. This included corrected visual acuity, cover test, and alternate cover and prism test using loose prisms at 1/3 and 6 m in primary position and in eccentric gazes.

Inferior oblique versions and ductions were documented. Extraocular movements were recorded on a 9-point scale using diagrammatic representation and numerical evaluation. Inferior oblique action was graded from -4 to +4 units depending on the magnitude of the under-elevation or over-elevation of the eye in the direction of action of the inferior oblique muscle during versions and the ductions were also noted. In maximal lateral version, a vertical deviation of approximately 10° was -1 or +1, 20° was -2 or +2, 30° was -3 or +3, and 40° was -4 or +4 units.

A successful outcome was defined as patients who were asymptomatic postoperatively.

All patients underwent a primary unilateral inferior oblique muscle myectomy at the temporal border of the inferior rectus muscle or a standard 10-mm inferior oblique recession performed by the same surgeon (JB) using a previously described operative technique.

RESULTS

The data of 79 patients who met the study criteria were analyzed. The mean age at surgery was 30.3 years with a range of 4 to 76 years. Twenty-seven patients were 16 years or younger, of whom 13 were younger than 8 years. Seventy-seven patients had fusion preoperatively in at least one position of gaze. Forty-three patients underwent inferior oblique myectomy and 36 patients underwent inferior oblique muscle recession. The patients were divided into three groups on the basis of the findings at 6 months postoperatively: group 1 = those with no inferior oblique underaction (51 patients); group 2 = those with inferior oblique underaction who were asymptomatic (23 patients); and group 3 = those with inferior oblique underaction who were symptomatic and required further surgery (5 patients). Among the 28 patients who at 6 months demonstrated postoperative inferior oblique underaction, 13 underwent recessions (36% of all recessions) and 15 underwent myectomies (35% of all myectomies).

The mean hyperdeviation preoperatively and 6 months postoperatively in primary position and in contralateral gaze for all three groups are detailed in Table 1. The mean preoperative and postoperative inferior oblique versions for the three groups are also
outlined in Table 1. There was no clinically significant difference between the mean vertical deviation in primary position and contralateral gaze preoperatively, being less than 1 PD between groups 1 and 2. The magnitude of the original primary position vertical deviation in patients who required a second surgical intervention varied considerably between 2 and 25 PD (group 3) (Tables 1 and 3).

The etiology of the inferior oblique overaction was taken from the patient records. Forty-three of 51 patients (84%) in group 1 had congenital or decompensating superior oblique underaction, 1 patient (2%) suffered from Crouzon’s syndrome, and the remaining 7 patients (14%) had acquired superior oblique underaction associated with trauma. In group 2, 17 of 23 patients (74%) had decompensated superior oblique underaction, 5 patients (22%) had acquired superior oblique underaction secondary to prior head trauma, and 1 patient (4%) had a birth-related neurological disease. Of the 5 patients in group 3, 1 (20%) had a masked bilateral superior oblique underaction, 1 (20%) had highly asymmetric bilateral superior oblique underaction, and 2 (40%) had a history of prior head and/or orbital trauma. The individual details of these 5 patients are described in Table 3.

The 51 patients in group 1 with no evidence of inferior oblique underaction at 6 months postoperatively demonstrated a trend toward a slightly greater overall inferior oblique overaction between 2 weeks and 6 months, increasing from +0.2 units of inferior oblique overaction at 2 weeks to +0.9 units at 6 months. In contrast, for the 23 asymptomatic patients in group 2, there was an overall increase in the documented inferior oblique underaction from -0.3 at 2 weeks to -1.0 units at 6 months (Table 1).

We also analyzed the documented, specific individual changes in inferior oblique action for patients in groups 1 and 2 between 2 weeks and 6 months postoperatively (Table 2). It was not uncommon for patients at approximately 2 weeks to appreciate discomfort on attempting a full ductional movement of the operated inferior oblique muscle and maintaining fixation in that position for an alternate cover and prism test. In total, 35 patients between groups 1 and 2 had inferior oblique underaction at 2 weeks. This underaction resolved by 6 months in 20 patients from group 1. Of the remaining 15 patients who were from group 2, inferior oblique underaction decreased but still persisted in 5, remained unaltered in 4, and increased further in 6 patients. Furthermore, 8 patients developed a spontaneous conversion of inferior oblique overaction to underaction between 2 weeks and 6 months, thus accounting for

### Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>Preop Mean Hyperdeviation in Primary Position (PD)</th>
<th>Postop 6 Mo Mean Hyperdeviation in Straight Contralateral Gaze (PD)</th>
<th>Mean Inferior Oblique Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.9</td>
<td>3.8</td>
<td>+2.7</td>
</tr>
<tr>
<td>2</td>
<td>13.1</td>
<td>3.8</td>
<td>+2.2</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>-7.8</td>
<td>+2.2</td>
</tr>
</tbody>
</table>

PD = prism diopters; preop = preoperative; postop = postoperative; IO = inferior oblique muscle.

*Negative values indicate reversal of vertical deviation.

*Group 1 = no postop IO underaction (51 patients); group 2 = postop IO underaction asymptomatic (23 patients); group 3 = postop IO underaction, further surgery (5 patients).

### Table 2

<table>
<thead>
<tr>
<th>Group</th>
<th>No Change OA/UA</th>
<th>Increase OA/UA</th>
<th>Decrease OA/UA</th>
<th>Spontaneous Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>OA to UA</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>UA to OA</td>
</tr>
</tbody>
</table>

OA = overaction; UA = underaction.

*Group 1 = no postoperative inferior oblique underaction (51 patients); Group 2 = postoperative inferior oblique underaction asymptomatic (23 patients).
We retrospectively analyzed the incidence and functional impact of postoperative inferior oblique underaction in previously unoperated patients who underwent unilateral inferior oblique weakening by either recession or myectomy. Von Noorden’s experience was that over a total of 23 patients who demonstrated inferior oblique underaction at 6 months (Table 2).

### TABLE 3

**Preoperative and Postoperative Measurements of 5 Patients With Postoperative Inferior Oblique Underaction Who Underwent Further Surgery**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Etiology</th>
<th>Preop</th>
<th>Postop</th>
<th>Preop</th>
<th>Postop</th>
<th>Preop</th>
<th>Postop</th>
<th>Preop</th>
<th>Postop</th>
<th>Age at Surgery (Y)</th>
<th>Primary Surgery</th>
<th>Symptoms</th>
<th>Further Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Asymmetric bilateral superior oblique underaction</td>
<td>14</td>
<td>-12</td>
<td>18</td>
<td>-15</td>
<td>+2</td>
<td>-1</td>
<td>-1</td>
<td></td>
<td>7</td>
<td>IO MY</td>
<td>PP diplopia, AHP</td>
<td>Contralateral IO RC</td>
</tr>
<tr>
<td>2</td>
<td>Masked bilateral superior oblique underaction</td>
<td>18</td>
<td>-35</td>
<td>25</td>
<td>-28</td>
<td>+3</td>
<td>-2</td>
<td>-2</td>
<td></td>
<td>26</td>
<td>IO MY</td>
<td>PP diplopia, AHP</td>
<td>Contralateral IO RC</td>
</tr>
<tr>
<td>3</td>
<td>Orbital trauma</td>
<td>2</td>
<td>-10</td>
<td>12</td>
<td>-6</td>
<td>+2</td>
<td>-0.5</td>
<td>-2</td>
<td></td>
<td>52</td>
<td>IO RC</td>
<td>PP diplopia</td>
<td>Ipsilateral SRS</td>
</tr>
<tr>
<td>4</td>
<td>Closed head trauma</td>
<td>25</td>
<td>14</td>
<td>35</td>
<td>25</td>
<td>+3</td>
<td>-1</td>
<td>-1</td>
<td></td>
<td>57</td>
<td>IO MY</td>
<td>PP and down gaze diplopia</td>
<td>Contralateral IRC</td>
</tr>
<tr>
<td>5</td>
<td>Decompensated longstanding</td>
<td></td>
<td>16</td>
<td>4</td>
<td>20</td>
<td>9</td>
<td>+1</td>
<td>-1</td>
<td>-1</td>
<td>47</td>
<td>IO MY</td>
<td>Down gaze diplopia, hypertropia</td>
<td>Contralateral IR PFS</td>
</tr>
</tbody>
</table>

PD = prism diopters; preop = preoperative; postop = postoperative; IO MY = inferior oblique myectomy; PP = primary position; AHP = abnormal head posture; IO RC = inferior oblique recession; IRC = inferior rectus recession; IR PFS = inferior rectus posterior fixation suture.

*Negative values indicate reversal of vertical deviation.*

**DISCUSSION**

We retrospectively analyzed the incidence and functional impact of postoperative inferior oblique underaction in previously unoperated patients who underwent unilateral inferior oblique weakening by either recession or myectomy. Von Noorden’s experience was that over a total of 23 patients who demonstrated inferior oblique underaction at 6 months (Table 2).
correction of the inferior oblique muscle was rare, except where a weakening operation was performed on a normally acting or only a slightly overacting muscle. Our findings indicated that asymptomatic underaction after surgery was common, with an incidence of 35% but with no particular predilection for recession or for myectomy with respective prevalence rates of 36% (13 of 36) and 35% (15 of 43) for both weakening procedures.

Surgically induced inferior oblique underaction has not received much attention in the literature, perhaps because, as we have noted, it does not commonly produce symptoms. In this series, although there were 5 of 79 patients (6%) with symptomatic postoperative diplopia, only 3 (3.8%) demonstrated ipsilateral inferior oblique underaction, whereas the other 2 had symptoms due to residual diplopia in primary position and/or down gaze related to the ipsilateral primary underacting superior oblique muscle.

Parks observed a greater percentage of overcorrections in the patients who had slight inferior oblique overactions preoperatively and a greater percentage of undercorrections in the patients who had marked overactions preoperatively. There was a similar trend in our study where the 6-month mean and median preoperative inferior oblique overaction was higher in group 1 (mean = +2.7 and median = +3.0 units), compared to the other two groups (mean = +2.2 and median = +2.0 units in each of groups 2 and 3) who demonstrated underaction. This difference in postoperative oblique function between groups 1 and 2 at 6 months may reflect the fact that patients with higher degrees of inferior oblique overaction preoperatively are less likely to develop a persistent underaction. We suspect that the interpretation of inferior oblique muscle action at 2 weeks postoperatively is less reliable than preoperatively or 6 months postoperatively because the inflammation associated with the healing process was still present and end-of-range movements were variably uncomfortable. This may in part account for our observations of the 2-week and 6-month postoperative data where an individual’s early 2-week postoperative overactions or underactions can subsequently change modestly but often seemingly unpredictably.

We observed that the degree of postoperative inferior oblique underaction for the asymptomatic patients in group 2 was mild, measuring a mean range of -1.0 units each at 6 months. This degree of underaction was only associated with a deviation in an eccentric position of gaze that proved functionally inconsequential. In contrast to some recent studies, we observed a further small deterioration in the mean versionsal underaction among this group of patients between 2 weeks and 6 months, although the mean changes recorded were small (less than 1.0 unit).

This inter-patient variation in clinical findings contrasted with the observations of Awadein and Gawdat, who reported an immediate postoperative inferior oblique underaction that subsequently resolved completely in their series, when all patients underwent bilateral asymmetric inferior oblique myectomies for bilateral inferior oblique overaction. Further prospective observations at more frequent postoperative time intervals may help to clarify the apparent anomaly between our experience of patients with unilateral binocular single vision and Awadein and Gawdat’s series of bilateral cases.

Most patients (60 of 74, 81%) in groups 1 and 2 had a congenital or decompensating unilateral superior oblique underaction, whereas the 5 cases in group 3 had a different etiologic mix of prior orbital or head trauma (2 patients) or masked (1 patient) or highly asymmetric (1 patient) bilateral superior oblique underaction. This different etiological mix of “functionally symptomatic” inferior oblique underaction cases may arguably represent predictive factor(s) for the less common postoperative behavior of the inferior oblique muscle in the minority.

Although this study is limited by its retrospective nature, the data indicated that vertical deviation reversal following inferior oblique recession and myectomy was common, persistent in many, but generally mild (-1 unit or less), asymptomatic, and only present in the field of maximal action of the inferior oblique muscle where analysis of its “end of range” function at 2 weeks postoperatively can still be subject to the limitations associated with postoperative discomfort in this position of gaze. The symptomatic minority (5 of 79 patients, 6.3%) may be divided into (1) those with primary position and/or contralateral gaze overcorrection and (2) those with residual undercorrection that remained symptomatic in primary position and/or down gaze. A minority will require additional operations where the associated “at risk” factors in this study were an underlying history of orbital and/or closed head trauma or highly asymmetrical and masked bilateral superior oblique underaction.
REFERENCES