Masked Bilateral Superior Oblique Palsy: Clinical Features and Diagnosis

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ABSTRACT

Ninety-two patients treated surgically between 1972 and 1983 were diagnosed initially as having a unilateral superior oblique palsy (SOP). On follow-up, eight (8.7%) developed findings of an SOP of the other eye. Such patients have “masked bilateral” superior oblique palsy. All eight patients had unilateral inferior oblique weakening with or without contralateral inferior rectus recession as the initial surgery. The “unmasking” of the contralateral palsy manifested in seven cases by an overaction of the contralateral inferior oblique muscle and appeared an average of 9.8 weeks (range five days to 11 months) after the first surgery. Their preoperative mean V-shift (7.6 diopters), mean excyclotorsion (5.7 degrees), and mean difference of hyperdeviation on right versus left tilt (19.6 diopters) were not significantly different from the respective values for patients with unilateral SOP (5.0 diopters, 4.3 degrees, 19.0 diopters).

Introduction

Superior oblique palsy (SOP) is a common problem encountered in large strabismus practices, and cases may be congenital or acquired. One of the clinical challenges in a given patient is to determine if the palsy is purely unilateral or bilateral.

Previous reports have defined criteria to separate the diagnosis of unilateral from bilateral SOP based on measurements of the vertical deviation in cardinal positions of gaze and on head tilts.1-13 The amount of excyclotorsion has been used to help separate these two categories.4,8-10,13 The presence or absence of head tilt, torsional diplopia, and chin-down head position in the patient's history can suggest to the clinician the relative likelihood of a unilateral or bilateral SOP. In addition, a history of closed head trauma should alert one to the possibility that a SOP is bilateral.5,6

There are patients with asymmetric bilateral SOP in whom the palsy of one eye, with its sequelae such as antagonist inferior oblique overaction, is more significant than the palsy in the other eye. In many such cases one can still clearly diagnose a bilateral palsy since the criteria for this diagnosis are satisfied. However, there are other patients with asymmetric involvement who only fulfill criteria for a unilateral SOP. Some time after these patients have surgery for the apparently unilateral palsy the second one manifests. These cases have been termed "masked bilateral" SOP14-15 or "see-saw paralysis" of the superior oblique.17

In previous reports of this entity there were no preoperative parameters that could allow one to predict the presence of a masked second palsy in cases of an apparently unilateral one.7,14-19 Its incidence is reported to be between 10% and 30% in series of unilateral palsies.7,14-16
In this study a large number of cases of surgically treated unilateral SOP were reviewed to determine the incidence of masked bilateral palsies. The clinical courses of the patients with masked bilateral palsies were examined to see if any common trends existed. Finally, the preop V-shift, excyclotorsion, and difference of hyperdeviation on head tilts of these patients and of the remaining patients with unilateral palsies were compared to determine if these two groups could be distinguished by these parameters. To our knowledge, no previous reports have made these comparisons between masked bilateral palsies and unilateral palsies.

Materials and Methods

Charts of all patients with a diagnosis of unilateral SOP treated surgically at the University of Iowa Hospitals between 1972 and 1983 were reviewed. From the records data were obtained from the immediate preoperative examination and from each subsequent visit until the last recorded examination.

The best corrected visual acuities were listed. Measurements of the deviations in the nine cardinal positions and on head tilts were done with prism and alternating cover testing with fixation at six meters on an accommodation-controlling target. Deviation at near was measured with the patient fixating on an accommodation-controlling target at 2/3 of a meter.

Underations for muscle on versions were graded from −4 (inability to move into the field of action) to 0 (normal action), with −3, −2, and −1 being interpolated between these extremes. Overactions were graded from 0 (normal action) to +4 (maximum overaction), with +1, +2, and +3 being interpolated between these extremes.

Excyclotorsion was measured with a Double Maddox Rod test with the light held at one meter in front of the patient, and the rods were oriented vertically (so as to create horizontal line images). If necessary, a vertical prism was used to dissociate the two images.

The presence of an abnormal head posture and the fields of gaze where the patient experienced diplopia were noted. The muscles operated upon and the amounts of surgery were recorded. If indicated, the patient had horizontal surgery at the same time as surgery for the vertical deviation.

Criteria for the diagnosis of a unilateral SOP in these patients were: 1) hyperdeviation in primary position on prism and alternating cover test; 2) positive “3-step test” including a positive Bielschowsky head tilt in which the hyperdeviation to the side of the paresis was at least five diopters greater than on tilt to the uninvolved side (and did not reverse); 3) evidence on versions of unilateral oblique dysfunction, either overaction of the ipsilateral (antagonist muscle) inferior oblique muscle or underaction of the involved superior oblique muscle, or both (with neither of these features in the other eye); and 4) excyclotorsion in primary position under 12 degrees by Double Maddox Rod testing. Criteria for diagnosis of the unmasked SOP had to satisfy these same criteria although

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Initial Eye</th>
<th>Age (yr.)</th>
<th>Hyperdeviation (PD)</th>
<th>Procedure</th>
<th>Deviation (PD)</th>
<th>Interval Postop to Onset of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Affected</td>
<td></td>
<td>Preop*</td>
<td></td>
<td>1 Day Postop*</td>
<td>Contralateral IO Oversion</td>
</tr>
<tr>
<td>Group I</td>
<td>1</td>
<td>R</td>
<td>26</td>
<td>3</td>
<td>Ortho</td>
<td>4 mo. +2</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>R</td>
<td>10</td>
<td>4</td>
<td>Ortho</td>
<td>8 days +1</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>R</td>
<td>21</td>
<td>3</td>
<td>Ortho</td>
<td>1 wk. +1</td>
</tr>
<tr>
<td>Group II</td>
<td>4</td>
<td>R</td>
<td>10</td>
<td>16</td>
<td>RIO rec 10 mm</td>
<td>2 RH(T)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>R</td>
<td>44</td>
<td>27</td>
<td>RIO rec 10 mm</td>
<td>9 RH(T)</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>L</td>
<td>18</td>
<td>30</td>
<td>LIO rec 10 mm</td>
<td>3 RH(T)</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>R</td>
<td>3</td>
<td>12</td>
<td>RIO rec 8 mm</td>
<td>5 RH</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>L</td>
<td>28</td>
<td>14</td>
<td>LIO rec 10 mm</td>
<td>Ortho</td>
</tr>
</tbody>
</table>

*In primary position
PD = Prism diopters; R = Right; L = Left; IO = Inf. Oblique; IR = Inf. Rectus; rec = Recession; a = Adjustable Suture Procedure; H(T) = Intermittent Hypertropia.

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there may have been a residual hyperdeviation of the originally involved eye on tilt to the same side or in gaze to the opposite field.

Prior to surgery, all patients had been followed for at least six months after the onset of their palsies with no change on at least two consecutive preoperative visits. All patients had at least 12 months' follow-up from the time of surgery.

From the data the net change in horizontal deviation, determined by prism and alternating cover test, from down gaze to up gaze was calculated for each patient. We have arbitrarily termed this the “V-shift,” as many cases did not demonstrate the minimum 15 diptor change required to class them as V-patterns.

In addition, the difference in hyperdeviation between right and left tilts was determined by subtracting the amount of the hyperdeviation on tilt to the side opposite to the palsy from the amount of hyperdeviation on tilt to the side ipsilateral to the palsy.

Statistical comparisons between the groups of patients with unilateral and masked bilateral palsies were done using the t-test (or the Welch t-test if the variance ratio was significant). Differences with P-value less than 0.05 were considered significant.

The eight patients with masked bilateral palsies were divided into two groups according to the initial surgery performed (Table 1). The three patients in Group I had small hyperdeviations in primary position with no hyperdeviation out of the field of action of the affected obliques. Unilateral inferior oblique weakening was the sole procedure done. The five patients in Group II had a hyperdeviation out of the field of action of the affected obliques as well as a moderately large vertical deviation in primary position. A combination of inferior oblique weakening and contralateral inferior rectus recession was performed in these cases.

The following case history illustrates a typical clinical course for patients with masked bilateral SOP (Case 5).

**Case Report**

This 44-year-old man presented to the Strabismus Clinic complaining of head tilt of several years' duration after sustaining head trauma in a motor vehicle accident. Visual acuities were 6/6 (20/20) OU with no correction. He had a 20 degree left head tilt to view an accommodation-controlling target at six meters. His preoperative measurements and versions are shown in Figure 1. The V-shift was two diptors. He had +3 overaction of the right inferior oblique muscle and a -1 underaction of the right superior oblique. The left inferior oblique and left superior oblique actions were normal. Double Maddox Rod testing two degrees of excyclotorsion in primary position.

A right inferior oblique recession of 10 mm with a left inferior rectus recession of 4 mm on an adjustable suture were done. Immediately after adjustment he had single binocular vision in primary position with fixation at distance and near. There was no torsion by Double Maddox Rod. The right inferior oblique was -1 underacting but the other three oblique muscles had normal function.

His findings five days postoperatively are shown in Figure 2. He still had single binocular vision in primary position. There was now a left hyperphoria in primary position with fixation at both distance and near and he showed reversing of hypertropias on tilts. The right inferior oblique still had -1 underaction but the left inferior oblique developed a +1 to +2 overaction. The superior oblique actions were still normal OU.

The findings eight months after surgery are shown in Figure 3. He was manifesting a 15 degree head tilt and complained of vertical diplopia in primary position and on right lateral gaze. His measurements fulfilled all the criteria for a unilateral left SOP. His left superior oblique was -1 underacting and the left inferior oblique was +3 overacting. Double Maddox Rod showed three degrees of excyclotorsion.

A left inferior oblique recession of 10 mm was done. Three weeks after this surgery he had no abnormal head position and had single binocular vision with fixation at distance and near in primary position and in down gaze. His findings are shown in Figure 4. There was a small phoria at distance and near fixation. Versions showed -1 underaction of both inferior oblique muscles and normal actions of his superior obliques. There was no torsion on Double Maddox Rod testing. There have been no changes in these findings nine months later.

**Results**

Ninety-two patients fulfilled the criteria described, of whom 54 (58.7%) were male and 38 (41.3%) were female. The right eye was involved in 53 (57.6%) cases and the left in 39 (42.4%). These data do not deviate significantly from an expected 50:50 distribution for sex or laterality (chi-square test, 1 degree of freedom).

The average age at initial surgery was 24.0 years with a range of three to 65 years. Average follow-up from last surgical procedure was 16.8 months with a range of 12 to 60 months.

From this sample, eight patients (8.7%) were eventually diagnosed as having an SOP of the other eye. All of these patients were males of average age 18.8 years with a range of three to 44 years. Their clinical data are presented in Table 1.

Six of the patients have had a second procedure to correct their “unmasked” SOP. The average time interval between the first and second surgeries was 13.0 months, with a range of four to 30 months. The average follow-up since their second surgeries has been 17.8 months with a range of 12 to 36 months. The follow-up times since surgery for the other two patients (Cases 4 and 6) were 18 and 13 months, respectively.

Only two of the eight patients (Cases 3 and 5) had a history of closed head trauma with loss of consciousness. Case 7 had a congenital SOP.

No patient had clinical evidence of “unmasking” of the second SOP within one day after the first surgical procedure (Table 1). All patients were orthophoric in primary position or had a small hyperdeviation of the same eye as before surgery. There was no patient with oblique dysfunc-
tion noted in the contralateral eye.

In seven of the eight cases, the first evidence of the second SOP was an overaction of the contralateral inferior oblique, and it manifested between five days and 11 months (mean 9.8 weeks) after the first surgery (Table 1).

Associated with this finding was a hyperdeviation of the eye in the opposite field of gaze. In four of the seven cases there was a hyperdeviation of the second eye seen in primary position for the first time at the same visit that the new inferior oblique overaction was detected. In the other three cases the hyperdeviation in primary position was first seen some time after the new inferior oblique overaction manifested.

In Case 6, a small right hypertropia was seen in primary position and in left gaze several weeks before the right inferior oblique was noted to be overacting. In addition, only in this case was a superior oblique underaction detected when the new inferior oblique overaction was first seen.

\[ \begin{array}{ccc}
4 \text{ XT} & 9 \text{ XT} & 40 \text{ RHT} \\
10 \text{ RHT} & 14 \text{ RHT} & \\
\hline
5 \text{ XT} & 8 \text{ XT} & 35 \text{ RHT} \\
14 \text{ RHT} & 27 \text{ RHT} & \\
\hline
2 \text{ XT} & 7 \text{ XT} & 35 \text{ RHT} \\
14 \text{ RHT} & 30 \text{ RHT} & \\
\hline
5 \text{ XT} & 37 \text{ RHT} & \\
\text{ NEAR = 4 XT}, 35 \text{ RHT} & \\
\end{array} \]

**FIGURE 1B**: Case 5, one day before initial surgery. Measurements in cardinal positions and on tilts.
FIGURE 2A: Case 5, five days after initial surgery. Versions: The right inferior oblique is -1 underacting. The left inferior oblique is overacting +1, and the superior oblique actions are normal.

Five of the cases had evidence of a second SOP within two weeks of the first surgery, and in all but one (Case 7) it manifested within four months after surgery. The distribution of intervals to detection of the second palsy did not differ between Group I (inferior oblique weakening only) and Group II (inferior oblique weakening and contralateral inferior rectus recession) patients.

The preoperative data of these eight patients were compared to the data of the other 84 patients with pure unilateral palsies to see if any of three parameters could allow separation of these two groups. Since bilateral SOP could be expected to have a larger difference in measurements between down gaze and up gaze (V-shift) and more excyclotorsion than unilateral SOP, these two items were analyzed. If a second palsy was masked, one could also expect the difference in hyperdeviation on right versus left tilt to be greater in a masked bilateral SOP. On tilting to the supposedly "uninvolved" side the vertical muscle changes from the masked palsy should reduce the amount of the hyperdeviation.

FIGURE 2B: Case 5, five days after initial surgery. Measurements in primary and secondary positions and on tilts.
FIGURE 3A: Case 5, eight months after first surgery (just prior to second surgery). Versions: The left inferior oblique is +3 overacting and the left superior oblique is −1 underacting.

The results of these analyses are listed in Table 2. There were no significant differences between the means of the two groups for these parameters and the ranges were very similar for each parameter. The excyclotorsion measured in primary position did not suggest that masked bilateral SOP cases were bilateral, and the measurements did not separate them from the pure unilateral cases. One patient with masked bilateral palsy and four with unilateral palsies were too young to cooperate for Double Maddox Rod testing. No torsion data were available for 19 other patients in the unilateral group.

Multiple regression analysis using all three variables failed to discriminate between the patients with unilateral and masked bilateral palsies.

Discussion

Jampolsky has stated that in cases of SOP “the paresis is bilateral until it is proved to be otherwise.” The diagnosis

FIGURE 3B: Case 5, eight months after first surgery (just prior to second surgery). Measurements in cardinal positions and on tilts.
of a bilateral SOP is often clearly evident in a patient whose palsies are symmetric. More difficult, however, is the diagnosis of a bilateral SOP with very asymmetric involvement.

Various authors have stressed the need for a careful examination to find clues to the presence of a second palsy in these cases. Such clues include: 1) a reversing of the hyperdeviation on head tilt to the “less involved” side, even if only a tiny amount of reversing of the hypertropia is measured; 2) an overaction of the inferior oblique of the “less involved” eye, however mild; 3) any reversing of the hyperdeviation from one to the other lateral position of gaze; and 4) excyclotorsion of a significant amount by Double Maddox Rod testing, generally over 12 to 15 degrees in primary position. Nevertheless, some cases of asymmetric palsies, such as those described in this study, have findings that do not reveal the presence of a second palsy despite scrupulous attention to such considerations.

Hermann documented nine cases of masked bilateral SOP in a series of 57 supposedly unilateral cases, and the average V-shift in the nine patients was 6.5 dipters. Souza-

FIGURE 4A: Case 5, three weeks after second surgery. Versions: The inferior obliques are −1 underacting and superior oblique actions are normal in both eyes.

FIGURE 4B: Case 5, three weeks after second surgery. Measurements in cardinal positions and on tilts.
Dias\textsuperscript{7} described findings in ten patients with this entity out of 39 unilateral cases. The four patients (of the ten) whose measurements he listed had an average of 10 dipters of V-shift. Neither author compared his series to that of the true unilateral palsies in his patient samples. The mean V-shift of 7.6 dipters in our eight patients was comparable to the values in these authors' reports, and was not significantly different from the patients with unilateral SOP.

Hermann\textsuperscript{14} listed excyclotorsion data on three of his patients, all having under 3 degrees. No other authors, to our knowledge, have listed their findings using this parameter either in cases of masked bilateral SOP or in comparing masked bilateral palsy cases to unilateral superior oblique palsies. The patients in our study had a slightly larger average amount of torsion with a larger range than in Hermann's few cases. However, the mean and range of torsion were comparable to the patients with unilateral palsies. Souza-Dias\textsuperscript{7} did not record any measurements of excyclotorsion in his patients.

To our knowledge, no previous reports have compared differences in hyperdeviation on tilts in masked bilateral palsies and unilateral palsies. No significant difference was found between the means in these two groups in this study.

Raab and Costenbader,\textsuperscript{19} although not addressing the issue of SOP in general, found that 30% of patients operated upon for a unilateral inferior oblique overaction developed overaction of the other inferior oblique. In almost all cases this manifested within six months of the initial surgery, and of these over 50% were seen within two months. Hermann\textsuperscript{14} listed these intervals for only three patients in his series and they were two weeks, one month, and nine months after the first surgery. In these cases the first manifestation of the second palsy was an overaction of the contralateral inferior oblique. In the four cases cited by Souza-Dias\textsuperscript{7} out of his series of ten, the intervals range from two to four months after the first surgery. All three cases in the series of Reynolds et al\textsuperscript{16} were unmasked by six months after surgery.

Our experience also suggests that the majority of these second palsies will manifest within the first few weeks after the first surgery. All but one patient had the second palsy diagnosed within four months of surgery.

In this study the incidence of masked bilateral SOP in a series of supposedly unilateral palsies was 8.7% (8 of 92). This is less than the frequency of 15.8% (9 of 57) reported by Hermann\textsuperscript{14} and 28.2% (10 of 39) listed by Souza-Dias.\textsuperscript{7} Scott\textsuperscript{45} estimated from his early experience that the incidence was about 10%. The relatively high incidence reported by Souza-Dias could be due to the fact no Double Maddox Rod results were reported. If any of his patients had registered values over 15 degrees then the possibility of a bilateral palsy would have been considered and these patients would not necessarily have been included in his 39 "unilateral" cases.

Previous studies have suggested that acquired bilateral SOP is generally associated with closed head trauma with loss of consciousness.\textsuperscript{46} However, five of seven acquired cases of masked bilateral SOP in our series had no history of head trauma. Thus, even in the absence of preceding trauma one should carefully examine for the presence of a second palsy.

All patients with masked bilateral SOP reported in Hermann's, Souza-Dias', and our series had inferior oblique weakening as part of the initial surgery in these cases. The four cases reported by Souza-Dias and five of our eight patients had a contralateral inferior rectus recession included in the surgery. From our data comparing Group I and II masked bilateral palsies (Table 1) it did not appear that the addition of the inferior rectus recession had any effect on the timing of manifestation of the second palsy, although our numbers are small.

It is difficult to explain why these unique cases of bilateral SOP cases are masked. None of the parameters tested allowed a clear separation of the patients from a large population of supposedly unilateral cases. Souza-Dias\textsuperscript{7} proposed a solution based upon the muscle sequelae that occur in SOP.

His premise is based upon the development of contracture of the superior rectus in the eye with the superior oblique with the more significant palsy. He postulates that the

\begin{table}[ht]
\centering
\begin{tabular}{|l|c|c|c|c|c|c|c|c|}
\hline
\textbf{Groups} & \textbf{V-Shift (Diopters)} & \textbf{Exycyclotorsion (Degrees)} & \textbf{Difference in Hyperdeviation} \\
 & \textbf{Mean} & \textbf{No. Cases} & \textbf{Range} & \textbf{Mean} & \textbf{No. Cases} & \textbf{Range} & \textbf{on Right vs. Left Tilts (Diopters)} \\
 & & & & & & & \\
\hline
Masked Bilateral Palsies & 7.6 & 8 & 0-15 & 5.7 & 7 & 2-11 & 19.6 & 8 & 6-60 \\
\hline
Unilateral Palsies & 5.0 & 84 & 0-20 & 4.3 & 61 & 0-15 & 19.0 & 84 & 5-50 \\
\hline
P-value & N.S. & & & N.S. & & & N.S. & & \\
\hline
\end{tabular}
\caption{V-SHIFT, EXYCILOTORSION, AND HEAD TILT DATA — MASKED BILATERAL VS. UNILATERAL PALSES}
\end{table}
superior rectus is, like the inferior oblique, an antagonist of the superior oblique. A superior oblique palsy leads to an overaction and contracture of the ipsilateral superior rectus in addition to the overaction of the ipsilateral inferior oblique. Once the superior rectus undergoes contracture the inferior rectus of that eye requires increased innervation to depress the affected eye. The yolk muscle of the inferior rectus, the contralateral superior oblique, will (by Hering's law) receive extra innervation to operate in its field and thus "hide" the paresis of this muscle.

His evidence for this argument is that, in his experience, there is frequently an overaction of the seemingly unaffected superior oblique. When the imbalance of forces in the first eye, including the superior rectus contracture, is relieved, the sequelae listed no longer operate. Since the contralateral superior oblique no longer receives increased innervation, its antagonist, the inferior oblique, can develop an overaction and a contracture. The findings of a SOP of this other eye manifest.

In reviewing the records of our eight patients, only two had any evidence of superior oblique overaction in the second eye, both +1. In addition, none of our eight patients had positive force duction tests at surgery that would have suggested a contracture of the superior rectus of the more affected eye. Thus, while the superior rectus contracture may be an underlying cause of "masking" in some cases, another factor, as yet unclear, would be needed to explain the phenomenon in other cases such as in our study.

Finally, von Noorden has described his wide experience with sensory tests for torsion, specifically Double Maddox Rod and Bagolini lenses. His results suggest that there are pitfalls in the interpretation of the subjective results obtained in such tests, thus clouding the issue of the precise cut-offs for unilateral versus bilateral palsies listed by other authors.4,8-11 Perhaps objective tools, such as observation of fundus torsion with the indirect ophthalmoscope, will help to separate the masked bilateral SOP cases from the true unilateral palsies. In recent years, observation of fundus torsion and fundus photography have been used to demonstrate objectively the presence of unilateral or bilateral torsion in cases of SOP.21-23 This technique is now being employed on a widespread basis. As expertise develops it could become possible to detect even small amounts of torsion and thus assist in detecting the bilateral asymmetric SOP among cases of seemingly unilateral ones.

Acknowledgment

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References