BIELSCHOWSKY HEAD-TILT TEST—I. OCULAR COUNTERROLLING AND BIELSCHOWSKY HEAD-TILT TEST IN 23 CASES OF SUPERIOR OBLIQUE PALSY


Department of Ophthalmology, Academisch Medisch Centrum, and the Netherlands Ophthalmic Research Institute, Amsterdam, The Netherlands

(Received 19 June 1984; in revised form 14 December 1984)

Abstract—We have measured the amplitude of ocular counterrolling (OCR) and the change in vertical deviation in the Bielschowsky head-tilt test (BHT) in 23 cases of unilateral superior oblique palsy. OCR was measured with a photographic method, using limbal, conjunctival vessels as landmarks. Average OCR of the healthy eye was 5.4 ± 2.4 (SD) deg either side, at 45 deg of body-tilt. BHT and OCR (of the healthy eye) were not related in the group as a whole. An important perturbing factor was the duration of the palsy. To clarify the relation between BHT, OCR and duration of palsy, the BHT/OCR ratio was calculated in each patient. Six cases with a palsy of presumed recent onset had BHT/OCR ratio of 0.57 ± 0.09, while twelve cases of long-standing palsy had a BHT/OCR ratio of 1.04 ± 0.71. This means that in cases of recent onset, the relation was relatively fixed. All high BHT/OCR ratios occurred in long-standing palsies, whether acquired or congenital. In our opinion, disproportionately large amplitudes in the Bielschowsky head-tilt test are caused by secondary innervational changes or contractures.

Ocular counterrolling  Bielschowsky head-tilt test  Cyclotorsion  Superior oblique palsy  Eye movements  Strabismus

INTRODUCTION

The vertical deviation (VD) of the affected eye in superior oblique palsy is augmented by head-tilt toward the affected side and reduced by head-tilt toward the other side. The diagnostic test that employs these alterations in VD of the affected eye is called Bielschowsky head-tilt test (BHT) (Nagel, 1871; Hofmann and Bielschowsky, 1900).

The superior oblique muscle is an intorter as well as a depressor, and the superior oblique, together with the superior rectus, executes the incyclotorsion evoked by head-tilt. Thus, when the superior oblique is paralysed, the eye goes up on head-tilt, by contraction of the superior rectus and inferior oblique, antagonized only by the inferior rectus.

A positive BHT is one of the diagnostic criteria of a superior oblique palsy. Other criteria are an excyclotropia and a VD of the affected eye, that increases on adduction and on infraduction. It is common practice to divide superior oblique palsies in congenital and acquired cases. Indicative of a congenital palsy are, for instance, a tilted head posture during childhood and lack of subjective cycloptropia. Acquired palsies mostly result from blunt head trauma. Often however, no cause is identifiable.

The reflex of in- and excyclotorsion of the healthy eye evoked by head-tilt is called ocular counterrolling (OCR). It is effected by alterations in innervational input of otolith-organs to oculomotor nuclei caused by differing direction and magnitude of gravitational force.

Occasionally, a patient with a superior oblique palsy exhibits a very large BHT amplitude. There is a considerable interpersonal variation in the amplitude of OCR, so it would seem logical, that a large BHT amplitude is caused by a large amplitude of naturally occurring OCR, which is the driving force in BHT (see Fig. 1). We have measured the amplitude of BHT and OCR in 23 cases of unilateral superior oblique palsy to see whether these were related. Ten of these cases have been commented upon previously (van der Meer, 1982). We found no relation between BHT and OCR in the group of patients as a whole.

We found, however, that in palsies of presumed recent onset, the ratio between BHT and OCR was relatively fixed. Disproportionately high BHT amplitudes occurred in long-standing cases only, whether congenital or acquired. It seems reasonable to assume, that secondary innervational changes or contractures are responsible for disproportionately high BHT amplitudes.

METHODS

For OCR measurements we used the method devised by Miller (1962), modified by Howard and Evans (1963). The patient was seated in a chair...
working, EF would then seem a reasonable guess, with a CD is parallel to the SR and IR vectors. As the 10 is still deg. Note that differences in vertical and torsional stiffness change in head-tilt will shift in a similar direction (points E and OCR, 5: deg incyclo and 5: deg excyclo. on average. If the muscle action of superior rectus (SR), inferior rectus (IR), superior oblique (SO) and inferior oblique (IO) are drawn. Points A and B represent the positions the eye assumes in OCR, 5 deg incyclo and 5 deg excyclo, on average. If the SO is paralysed, the eye will move in a direction opposite to the SO vector (point X). The positions the eye will assume on head-tilt will shift in a similar direction (points E and F).

In the case drawn, a VD of 5 deg and an excyclotropia of 6 deg is assumed. What is the path the eye will take in BHT? Points A and B represent the positions the eye assumes in OCR, 5 deg incyclo and 5 deg excyclo, on average. If the SO is paralysed, the eye will move in a direction opposite to the SO vector (point X). The positions the eye will assume on head-tilt will shift in a similar direction (points E and F).

Cyclophoria was measured with a Maddox groove that could rotate in a device with a circular scale and a spirit-level that was held horizontally by the examiner. The Maddox groove was rotated until the red line passed through the image of the fixation-light if the eyes were aligned. If, on the other hand, the affected eye deviated upward, the red line would appear below the image of the fixation-light. The place where the red line intersected the ordinate of the tangent screen was reported by the patient.

The measurements were repeated with the head turned 25 deg to the left, right, up and down, resulting in adduction, abduction, infraduction and supraduction of the healthy eye. Finally the measurements were repeated on 45 deg of head-tilt toward the right and left shoulder (Bielschowsky head-tilt test).

Cyclophoria was measured with a Maddox groove that could rotate in a device with a circular scale and a spirit-level that was held horizontally by the examiner. The Maddox groove was rotated until the red line, as seen by the affected eye, appeared parallel to the ordinate of the tangent screen, while the other eye was uncovered.

All patients were diagnosed by one of the authors (R.A.C.) as cases of superior oblique palsy, between July 1980 and December 1983. Ten cases were right palsies, 13 cases were left palsies. All patients had a VD of the affected eye, in all cases increasing on head-tilt toward the affected side (BHT), in all cases increasing in adduction, and in 17 cases increasing in infraduction. Children under 10 years of age were excluded from the study, as well as disabled and edentate patients.

RESULTS

Patient number, date of onset of complaints and essential history are given in Table 1. Patient number, date of birth, affected eye, OCR, deviations of the affected eye with the healthy eye in primary position, subjective cyclophoria, VD's in various gaze-positions and on head-tilt (BHT) are given in Table 2. The measurements are preceded by the date of their collection, in parenthesis. Not all measurements of horizontal, vertical and cyclo deviations are shown. That set of measurements was selected that was closest in date to the OCR measurement. Contrariwise, all BHT measurements are shown. VD's are
shown for the following gaze-positions of the healthy eye: 25° right/25° left, 25° up/25° down and 25° adduction-and-up/25° adduction-and-down. Two cases, initially diagnosed as cases of superior oblique palsy, were excluded from the study because of uncertainty about the diagnosis. One had a large concomitant vertical deviation, the other had a vertical deviation that decreased on adduction. No other cases of unilateral superior oblique palsy were observed.

Averaged data are shown in Table 3. To clarify the relation between BHT, OCR and duration of the palsy, the BHT/OCR ratio was calculated for each BHT measurement, using the total OCR of the healthy eye in each patient as denominator. These ratios are represented graphically in Fig. 2 by the ordinate. Duration of the palsy is represented logarithmically on the abscissa. As apparent from Fig. 2, the patients fell into two groups, consisting of recent and long-standing cases. So two subsets of
patients were composed. Patients 9, 12, 17, 18, 21 and 23 all had a superior oblique palsy of recent onset, first seen within six months. Patients 7, 8 and 22 were excluded from this group for reasons mentioned in the discussion section. Patients 1, 2, 3, 5, 6, 11, 13, 14, 15, 16, 19 and 20 all had a long-standing palsy, first seen more than 5 years after onset. Because of the arbitrarily set limits of 1 and 5 years, patients 4 and 10 were entered into neither subset.

In the first nine patients, OCR was measured not only after body-tilt, but also after head-tilt, to quantify the influence of tonic neck-reflexes. The difference proved to be small, $0.25 \pm 1.39 \text{deg}$, head-tilt yielding more OCR ($n = 18 = 2 \times 9$ healthy eyes). Similarly, in 16 healthy volunteers, we found a difference in OCR between head-tilt and body-tilt of $0.43 \pm 1.07 \text{deg}$, body-tilt yielding more OCR; their OCR was $5.33 \pm 1.72 \text{excyclo}$ and $5.71 \pm 2.17 \text{incyclo}$, on a 45-deg body-tilt ($n = 64 = 2 \times 32$ healthy eyes). Because the difference was small and fixation of the head could not be controlled as accurately in head-tilt as opposed to body-tilt, the method was abandoned.

Each OCR figure in Table 2 is the average taken from three measurements. These measurements are not shown individually. The difference between the second measurement minus the first measurement was $+0.2 \pm 0.8 \text{deg}$. The difference between the third measurement minus the second measurement was $+0.0 \pm 0.8 \text{deg}$.

**DISCUSSION**

We found no relation between BHT and OCR in the group of 23 patients as a whole. Interfering factors were searched for. The duration of the palsy proved to be an important perturbing factor. In

\begin{table}
\centering
\begin{tabular}{|c|c|c|}
\hline
Patient number & Date of onset of complaints & Essentials of history \\
\hline
1 & 1974 & Spontaneous onset of diplopia; sustained commotio in 1968; tort +, ster + \\
2 & 1975 & Car-accident; 3 weeks in coma; tort +, ster - \\
3 & Cong & Tort - \\
4 & 1979 & Car-hood hit head; tort +, ster + \\
5 & 1964 & 3 weeks in coma after skull-base fracture; tort - \\
6 & Cong & Vertigo for years; tort -; ster + \\
7 & 5.10.80 & Fallen in bath on left side of face, complained, paradoxically, of periods of diplopia on head-tilt to right shoulder, while left sup obi was affected \\
8 & 18.1.81 & Hit in fight, for a while unconscious; spontaneous resolution; tort + \\
9 & 8.80 & Spontaneous onset; fallen on right eye brow in 1974; tort + \\
10 & 10.7.83 & Spontaneous diplopia, in a few weeks progressive; sustained commotio in remote past \\
11 & 1969 & Fallen; tort +, ster + \\
12 & 6.81 & Fallen on face; tort -; ster +; complained also of diplopia after car-accident, 3 years previously, but then spontaneous resolution occurred \\
13 & 1958 & Car-accident; tort +, ster + \\
14 & Cong & Tort - \\
15 & Cong & Tort since 1980; in 1961 "convergence insufficiency" diagnosed elsewhere \\
16 & 1970 & Commotio; tort + \\
17 & 4.82 & Hit by twig in eye. spontaneous resolution. tort +, ster - \\
18 & 31.8.82 & Door-knob in eye \\
19 & 1975 & Diplopia started after "influenza" \\
20 & Cong & Tort - \\
21 & 1.92 & Unknown cause; tort + \\
22 & 20.9.82 & Herpes zoster; spontaneous resolution \\
23 & 1.8.83 & Unknown cause; tort + \\
\hline
\end{tabular}
\caption{Patient number and essential patient data}
\end{table}

In Fig. 2 the relation between BHT, OCR and duration of the palsy is depicted. The clustering of BHT/OCR ratios of patients with a superior oblique palsy of recent onset around 0.57 is conspicuous. Other interfering factors could be:

(a) Patient selection. The group is biased toward cases with problems in diagnosis, because these cases will preferentially be referred to a University Clinic. The problem in diagnosis might be related to an abnormal BHT/OCR ratio.

(b) Patient 8 and 22 had an incomplete, quickly resolving palsy. This might have been the case in other patients too. In some apparently complete palsies, electromyographical activity can be registered in the superior oblique muscle (A. B. Scott, personal communication).

(c) Patient 7 probably had a trochlear lesion. He complained of periods of diplopia on head-tilt toward the right shoulder, while the left superior oblique was affected. It is possible that the tendon of the left superior oblique was not entirely free to move through the trochlea, as a result of the trauma to the left orbit.

(d) Differing angles between superior oblique tendon and sagittal plane. According to Fink (1950), this angle may vary considerably from person to person. The larger the angle, the less BHT per OCR.

(e) Tonic neck-reflex. OCR was measured on body-tilt, while BHT was measured on head-tilt. We found, however, little difference between OCR on head-tilt and OCR on body-tilt.

(f) Cycloversion and convergence do occur spontaneously, up to 1 degree (Diamond et al., 1982). This may have influenced the OCR measurements slightly.

(g) From the work of Nelson and Cope (1971), it can be seen that OCR amplitudes of yoke eyes in
Table 2. Patient number, date of birth, affected eye, OCR, deviations of the affected eye (healthy eye in primary position), VD's in various gaze positions, cyclophoria and VD's on head-tilt (HIT). The measurements are preceded by the date of their collection, in brackets.

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Date of birth</th>
<th>Affected eye</th>
<th>Date of OCR measurement</th>
<th>OCR of affected eye</th>
<th>OCR of healthy eye</th>
<th>Date of measurement and HIT</th>
<th>Head (°)</th>
<th>VD on right gaze</th>
<th>VD on left gaze</th>
<th>VD on up gaze</th>
<th>VD on down gaze</th>
<th>VD on right gaze</th>
<th>VD on left gaze</th>
<th>VD on up gaze</th>
<th>VD on down gaze</th>
<th>Cyclophoria</th>
<th>Other HIT measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (11.10.63)</td>
<td>OD (02.07.80)</td>
<td>OD (02.07.80)</td>
<td>5.4/7.0 8.1/7.4</td>
<td>(09.04.80)</td>
<td>-2 +9 4/15</td>
<td>9/9</td>
<td>+2 11/3</td>
<td>(19.02.80)</td>
<td>13/5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 (03.09.47)</td>
<td>OD (02.10.80)</td>
<td>OD (02.10.80)</td>
<td>5.0/6.5 10.3/9.7</td>
<td>(04.11.80)</td>
<td>-2 +8 25/7</td>
<td>5/8</td>
<td>+3 17/2</td>
<td>(15.08.80)</td>
<td>2/0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 (15.07.72)</td>
<td>OD (07.15.80)</td>
<td>OD (07.15.80)</td>
<td>5.4/7.2 5.0/6.0</td>
<td>(04.11.80)</td>
<td>-2 +10 3/18</td>
<td>6/8</td>
<td>+3 17/2</td>
<td>(23.08.81)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 (01.06.36)</td>
<td>OD (07.01.81)</td>
<td>OD (07.01.81)</td>
<td>4.7/5.7 2.7/3.4</td>
<td>(02.12.80)</td>
<td>-2 +12 13/12</td>
<td>2/16</td>
<td>+6 19/6</td>
<td>(23.09.81)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 (26.09.44)</td>
<td>OD (06.01.81)</td>
<td>OD (06.01.81)</td>
<td>3.4/5.7 3.4/5.0</td>
<td>(12.14.80)</td>
<td>Same</td>
<td>0 +6 11/2</td>
<td>4/6</td>
<td>+3 17/2</td>
<td>(21.11.80)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 (23.06.65)</td>
<td>OD (31.01.81)</td>
<td>OD (31.01.81)</td>
<td>4.8/6.4 4.6/5</td>
<td>(04.11.80)</td>
<td>Same</td>
<td>-3 0 10/6</td>
<td>5/6</td>
<td>+3 17/2</td>
<td>(09.03.81)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 (16.05.51)</td>
<td>OD (07.04.81)</td>
<td>OD (07.04.81)</td>
<td>4.8/5.6 5.5/1.5</td>
<td>(12.14.80)</td>
<td>Same</td>
<td>-3 +8 19/4</td>
<td>4/10</td>
<td>+3 17/2</td>
<td>(23.09.81)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 (12.12.46)</td>
<td>OD (21.04.81)</td>
<td>OD (21.04.81)</td>
<td>2.5/3.0 3.6/2.2</td>
<td>(16.03.81)</td>
<td>0 +1 4/0</td>
<td>1/4</td>
<td>+1 1/1</td>
<td>(23.02.81)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 (22.03.81)</td>
<td>OD (08.03.81)</td>
<td>OD (08.03.81)</td>
<td>2.5/2.0 4.3/2.6</td>
<td>(27.04.81)</td>
<td>-1 +4 0/6</td>
<td>1/1</td>
<td>+3 6/2</td>
<td>(09.03.81)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 (18.05.10)</td>
<td>OD (13.05.81)</td>
<td>OD (13.05.81)</td>
<td>6.2/8.6 7.3/7.7</td>
<td>(30.03.81)</td>
<td>+3 +7 7/9</td>
<td>6/3</td>
<td>+3 1/3</td>
<td>(05.02.76)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 (26.08.64)</td>
<td>OD (20.04.82)</td>
<td>OD (20.04.82)</td>
<td>4.5/2.3 5.2/2.2</td>
<td>(23.03.82)</td>
<td>+9 +15 4/10</td>
<td>5/1</td>
<td>+3 1/3</td>
<td>(23.03.82)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 (05.05.48)</td>
<td>OD (03.05.82)</td>
<td>OD (03.05.82)</td>
<td>5.4/5.5 3.9/4.2</td>
<td>(12.14.80)</td>
<td>Same</td>
<td>+5 +8 8/7</td>
<td>6/8</td>
<td>+2 7/15</td>
<td>(13.08.81)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 (21.08.45)</td>
<td>OD (03.05.82)</td>
<td>OD (03.05.82)</td>
<td>6.8/7.6 5.3/8.6</td>
<td>(27.04.81)</td>
<td>Same</td>
<td>0 +3 3/8</td>
<td>2/2</td>
<td>+2 4/1</td>
<td>(23.03.82)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 (19.03.72)</td>
<td>OD (17.03.82)</td>
<td>OD (17.03.82)</td>
<td>5.0/4.2 2.8/1.0</td>
<td>(04.11.80)</td>
<td>Same</td>
<td>-1 +1 7/1</td>
<td>1/1</td>
<td>+2 1/3</td>
<td>(03.02.82)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 (13.08.36)</td>
<td>OD (24.03.82)</td>
<td>OD (24.03.82)</td>
<td>4.4/1.3 6.6/1.3</td>
<td>(23.03.82)</td>
<td>Same</td>
<td>+4 +13 9/6</td>
<td>8/9</td>
<td>+3 1/4</td>
<td>(16.02.82)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 (30.07.63)</td>
<td>OD (06.07.82)</td>
<td>OD (06.07.82)</td>
<td>4.1/4.9 4.6/4.8</td>
<td>(23.03.82)</td>
<td>Same</td>
<td>-15 +5 1/5</td>
<td>3/8</td>
<td>+3 4/8</td>
<td>(03.02.82)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 (30.09.46)</td>
<td>OD (09.07.82)</td>
<td>OD (09.07.82)</td>
<td>8.4/6.4 2.6/3.3</td>
<td>(21.03.82)</td>
<td>-1 +3 5/2</td>
<td>1/9</td>
<td>+3 1/4</td>
<td>(09.09.82)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 (29.06.53)</td>
<td>OD (15.10.82)</td>
<td>OD (15.10.82)</td>
<td>11.5/9.5 6.9/5.5</td>
<td>(23.03.82)</td>
<td>Same</td>
<td>-2 +9 3/4</td>
<td>3/10</td>
<td>+3 4/4</td>
<td>(30.11.82)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 (01.08.34)</td>
<td>OD (28.10.82)</td>
<td>OD (28.10.82)</td>
<td>5.7/3.5 3.6/5.2</td>
<td>(06.07.82)</td>
<td>-1 +10 4/8</td>
<td>5/18</td>
<td>+7 10/22</td>
<td>(18.05.82)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 (17.10.57)</td>
<td>OD (29.10.82)</td>
<td>OD (29.10.82)</td>
<td>2.4/1.1 1.9/1.6</td>
<td>(23.03.82)</td>
<td>Same</td>
<td>0 +9 13/2</td>
<td>5/16</td>
<td>+2 3/18</td>
<td>(22.09.82)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 (17.08.15)</td>
<td>OD (01.03.83)</td>
<td>OD (01.03.83)</td>
<td>0.8/2.5 0.3/2.6</td>
<td>(21.02.83)</td>
<td>-2 +3 1/6</td>
<td>3/1</td>
<td>+1 2/1</td>
<td>(03.02.82)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 (27.07.03)</td>
<td>OD (26.10.83)</td>
<td>OD (26.10.83)</td>
<td>6.4/3.1 4.0/4.0</td>
<td>(30.07.83)</td>
<td>Same</td>
<td>+2 +4 0/3</td>
<td>0/1</td>
<td>+1 2/1</td>
<td>(25.11.82)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23 (24.10.36)</td>
<td>OD (11.11.83)</td>
<td>OD (11.11.83)</td>
<td>8.5/7.5 4.4/8.1</td>
<td>(24.10.83)</td>
<td>Same</td>
<td>+5 5/17</td>
<td>4/8</td>
<td>-4 10/5</td>
<td>(24.10.83)</td>
<td>1/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Average OCR, VD, alterations in VD in BHT and various gaze-positions, BHT OCR ratio and subjective cyclophoria in all patients and in two subsets of patients comprising palsies of recent onset (shorter than 1 year) and long-standing palsies (longer than 5 years) (considering Table 3 averaged data are given separately for patients 9, 12, 17, 18, 21 and 23, all cases of superior oblique palsy of presumed recent onset. Patients 7, 8 and 22 were excluded from this group for reasons mentioned above. Averaged data are also given for patients 1, 2, 3, 5, 6, 11, 13, 14, 15, 16, 19 and 20, comprising a group of long-standing palsies. Apart from a greater variability in BHT/OCR ratio, the latter 12 patients had, on average, smaller differences in VD on up and down gaze (secondary concomitance), but larger differences in VD on adduction.

From this study it appears that the relation between BHT and OCR is relatively fixed in palsies of recent onset. It seems reasonable to assume that high BHT/OCR ratio's, i.e. disproportionately large BHT amplitudes, are caused by secondary innervaloratory changes or contractures.

Acknowledgements—We would like to thank Professor D. A. Robinson and Professor G. Kommerell for their encouragement and valuable comments. We would like to thank Stella R. Ompi for art-work.

REFERENCES


