Alteration of orbicularis oculi reflex by posterior fossa tumors

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The orbicularis oculi reflex response to electrical stimulation of the supraorbital nerve was studied in 14 cases of intrinsic brain stem lesions (2 mesencephalic, 6 pontine, and 4 medullary neoplasms, and 2 pontine syringes) and 20 cases of lesions extrinsic to the brain stem (6 cerebellar and 14 cerebellopontine angle tumors). The early reflex was abnormal in all but three cases of medullary tumors and one case of cerebellar tumor. Alteration of the early reflex by posterior fossa tumors reflects either delayed conduction through the pons due to intrinsic pontine lesions or extrinsic compression of the pons, or indicates trigeminal or facial nerve involvement by tumor. The late reflex with its direct and consensual components is useful in distinguishing afferent from efferent delay (or block). Mixed patterns suggest combined involvement of the trigeminal and facial nerves or a relatively widespread brain-stem lesion. This simple technique appears to be a useful addition to clinical observation in assessment of posterior fossa tumors.

KEY WORDS - orbicularis oculi reflex - blink reflex - posterior fossa tumors - brain stem conduction - pontine conduction - trigeminal nerve - facial nerve

REFLEX contraction of the orbicularis oculi muscle in response to a glabellar tap or electrical stimulation of the supraorbital area consists of two separate responses, an early ipsilateral reflex and a late bilateral reflex: the trigeminal nerve provides the afferent limb and the facial nerve the efferent. Although details of central pathways of these reflexes are unknown, the ipsilateral early reflex is now believed to be transmitted through the pons and lateral medulla via a simple oligosynaptic arc. The bilateral late reflex is relayed through the pons and lateral medulla via a polysynaptic arc. Afferent impulses in the trigeminal nerve enter the pons, descend to the ipsilateral trigeminal spinal nucleus, and then ascend to make connections with both the ipsilateral and contralateral facial nuclei in the pons.

The clinical usefulness of these reflexes in evaluating the trigeminal and facial nerves has been described. Alteration of the reflexes by lesions of the brain stem has been reported in multiple sclerosis and in brain-stem strokes. This study will describe the applications of this technique to various posterior fossa tumors and syringes.

Method and Clinical Material

Normal Values

The technique of performing the test has been described. The normal range (mean
values ± 3 S.D.) of latency and of latency difference between the two sides in one subject is summarized in Table 1. Any value beyond these intervals as defined above is considered abnormal in this study. In assessing the early reflex, the wave form of the response should also be taken into consideration. This criterion is admittedly less precise than that of the latency, but very irregular, multiphasic responses are not normally seen when surface electrodes are used for recording, and may be considered abnormal if reproducible. Simultaneous recordings from surface electrodes placed over the right and left orbicularis oculi muscles show that unilateral percutaneous stimulation of the supraorbital nerve evokes an early reflex on the side of stimulation and a late reflex on both sides. It is helpful to consider the latter comparable to the pupillary light reflex; the ipsilateral component may then be referred to as the "direct late reflex" and the contralateral component as the "consensual late reflex." Thus, stimulation on the right evokes a right early reflex, a right direct late reflex, and a left consensual late reflex. The consensual late reflex is named after the side of recording and not the side of stimulation.

On the basis of a delayed early reflex, it is not possible to determine which part of the reflex arc is involved. The late reflex is of considerable value in this regard. A unilateral delay of the late reflex on the right regardless of the side of stimulation, for example, implicates the efferent path (facial nerve and caudal pons) on the right, as with the pupillary light reflex in right oculomotor nerve palsy. A bilateral delay of the late reflex on right-sided stimulation, on the other hand, implicates the afferent path (trigeminal nerve, pons and trigeminal spinal tract and nucleus) on the right, as with the pupillary light reflex in right optic atrophy. Patterns not compatible with either afferent or efferent delay (or block) suggest combined involvement of both the trigeminal and facial nerves or a relatively widespread brain stem lesion.

In addition to the reflex responses, the direct motor response of the orbicularis oculi to stimulation of the facial nerve is routinely studied.

Clinical Material

Of 34 patients included in this study (Table 2) 14 had intrinsic brain-stem lesions (2 mesencephalic, 6 pontine, and 4 medullary neoplasms, and 2 pontine syringes) and 20 had lesions extrinsic to the brain stem (6 cerebellar tumors including one abscess and 14 cerebellopontine angle tumors). The diagnosis was verified at autopsy in four and at surgery in 22. In the rest, clinical or roentgenological findings were compared to the result of the reflex study.

Results

In five cases (1 medullary and 4 cerebellopontine angle tumors) seen only postoperatively after the facial nerve had been surgi-

| TABLE 1 |
| Latency of motor response and early and late reflex in 30 normal subjects |

<table>
<thead>
<tr>
<th>Latency</th>
<th>Direct Motor Response (msec)</th>
<th>Early Reflex (msec)</th>
<th>Late Reflex (msec)</th>
<th>Consensual</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>3.15</td>
<td>10.6</td>
<td>31.3</td>
<td>31.6</td>
</tr>
<tr>
<td>S.D.</td>
<td>0.28</td>
<td>0.82</td>
<td>3.33</td>
<td>3.78</td>
</tr>
<tr>
<td>&lt;mean ± 3 S.D.</td>
<td>&lt;4.0</td>
<td>&lt;13.1</td>
<td>&lt;41</td>
<td>&lt;43</td>
</tr>
</tbody>
</table>

Latency differences between two sides in one subject

<table>
<thead>
<tr>
<th>Latency</th>
<th>Direct Motor Response (msec)</th>
<th>Early Reflex (msec)</th>
<th>Late Reflex (msec)</th>
<th>Consensual</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>0.14</td>
<td>0.31</td>
<td>1.14</td>
<td>(2.36)</td>
</tr>
<tr>
<td>S.D.</td>
<td>0.17</td>
<td>0.31</td>
<td>1.25</td>
<td>(1.90)</td>
</tr>
<tr>
<td>&lt;mean ± 3 S.D.</td>
<td>&lt;0.6</td>
<td>&lt;1.2</td>
<td>&lt;5</td>
<td>(&lt;8)</td>
</tr>
</tbody>
</table>

(comparing right-sided response to simultaneously recorded left-sided response)

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TABLE 2

Orbicularis oculi reflex in 34 cases of posterior fossa lesions

<table>
<thead>
<tr>
<th>Clinical Diagnosis</th>
<th>No. of Cases</th>
<th>Early Reflex</th>
<th>Late Reflex</th>
<th>Direct Motor Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Delayed or Absent</td>
<td>Normal</td>
<td>Delayed or Absent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Both Sides</td>
<td>One Side</td>
<td></td>
</tr>
<tr>
<td><strong>Intrinsic brain stem lesions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>syrinx (pontine)</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>mesencephalic tumor</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>pontine tumor</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>medullary tumor</td>
<td>3 +1*</td>
<td>1*</td>
<td>3</td>
<td>1*</td>
</tr>
<tr>
<td><strong>Extrinsic brain stem lesions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cerebellar tumor</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>cerebellopontine angle tumor</td>
<td>10 +4*</td>
<td>1 +1*</td>
<td>9 +3*</td>
<td>2</td>
</tr>
</tbody>
</table>

* Seen only postoperatively after the facial nerve had been surgically sacrificed.
† Includes one case of cerebellar tumor and six cases of cerebellopontine angle tumors previously reported in references 6 and 9.

ally sacrificed, the direct motor response of the facial nerve as well as the early and late reflexes were absent on the side of the lesions (efferent block). Of the remaining 29 cases, the early reflex was normal in four (3 medullary and 1 cerebellar tumor) and abnormal on one side in eight and on both sides in 17. The late reflex was normal in 12 and abnormal in 17 with findings compatible with an afferent delay (or block) in five, an efferent delay in two and other abnormality in 10. The direct motor response of the facial nerve was normal in all the 29 cases. The results of the orbicularis oculi reflex are summarized in Table 2 according to the clinical localization and etiology of the posterior fossa lesions. (The response of the patients was classified as normal or abnormal according to the criteria stated in Table 1.) Figure 1 shows distribution of the latency of the direct motor response and early reflex in these patients and in 30 normal controls previously reported. Both normal and abnormal sides for the patients were grouped together and compared to the normal controls, the overlap being due to those responses from patients which showed normal latencies on one or both sides.

Three characteristic cases will be briefly described.

![Graph showing the distribution of the latency (msec) of the direct motor response of the facial nerve and early reflex in 30 normal subjects (clear) and 34 patients with posterior fossa lesions (shaded). The early reflex was considerably delayed in patients with posterior fossa lesions while the direct motor response was normal except for five absent responses seen after sacrificing the facial nerve at surgery.](image-url)
Orbicularis oculi reflex with tumors

Case Reports

Case 1

When first seen in October, 1968, this 5-year-old girl had mild right hemiparesis, left facial weakness, right-sided ataxia, horizontal and vertical nystagmus at rest, and a Babinski sign on the right. The early reflex was normal (10.0 msec) on the right and absent on the left. She was given radiation treatment. The reflex study remained unchanged during each of the next five occasions. In a study made April 29, 1969 (Fig. 2), associated with clinical improvement, the early reflex appeared on the left but was delayed (13.0 msec) when compared to the one on the right (10.0 msec). At the end of May she developed papilledema. Ventriculocisternostomy was performed. On July 9 she showed internuclear ophthalmoplegia on right lateral gaze. The left early reflex was one again absent. The right early reflex (10.0 msec) became more irregular and multiphasic. The left direct and left consensual late reflexes (45 to 50 msec) were delayed, suggesting a left efferent delay. She died in October, 1969. Autopsy revealed glioblastoma multiforme infiltrating most of the brain stem including mesencephalon, pons, and medulla, with maximal involvement in the pons (Fig. 3).

Case 2

A 36-year-old man with lymphosarcoma developed quadriplegia with a sensory level at C-5 on May 18, 1970; a myelogram showed multiple filling defects. On May 22, the early reflexes (12.0 msec on the right, 11.5 msec on the left) and the late reflexes (32 msec) were normal (Fig. 4, left). He was given radiation therapy and could use his arms normally by June. On July 16, he developed irregular rotatory nystagmus with oscillopsia. The early reflex on July 17 was normal (11.9 msec) on the left but delayed (16.8 msec) on the right. On July 20 (Fig. 4, right), the early reflexes were delayed bilaterally (18.0 msec on the right, 16.0 msec on the left).

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Fig. 2. Case 1. Tracings for left-sided stimulation (left), and right-sided stimulation (right). For the top tracing, the stimulus was delivered to the facial nerve, and the direct motor response (horizontal bars) was recorded from ipsilateral orbicularis oculi. For the middle tracing and bottom pair, the stimulus was delivered to the supraorbital nerve. In the middle tracing, the early reflex (horizontal brackets) was recorded from the ipsilateral orbicularis oculi with a faster sweep speed (5 msec/cm). In the bottom pair, in addition to the unilateral early reflex (brackets), the bilateral late reflexes (brackets with broken lines) were simultaneously recorded from the ipsilateral (upper tracing of the pair) and the contralateral (lower tracing) orbicularis oculi with a slower sweep speed (10 msec/cm). The direct response was normal on both sides. The early reflex was delayed (13.0 msec) on the left and, although normal (10.0 msec) in latency, its waveform was abnormally irregular on the right. The left direct and left consensual late reflexes were delayed (50 msec) while the right direct and right consensual late reflexes were normal (30 msec), suggesting a left efferent delay.

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Fig. 3. Case 1. Brain specimen showing that glioblastoma multiforme has replaced most of the brain stem. (Photograph by courtesy of Drs. W. F. McCormick and S. Schochet, Jr., Iowa City.)

The right direct and the left consensual late reflexes were slightly delayed (38 msec) when compared to the left direct and the right consensual late reflexes (30 msec). He died on the following day. Autopsy revealed perivascular infiltration of neoplastic cells throughout the brain stem, including mesencephalon, pons, and medulla with maximal involvement in the medulla.

Case 3

A 17-year-old woman developed vomiting and slight ataxia in August, 1971. The early reflexes on September 1, 1971, were normal in latency (9.3 msec on the right, 8.4 msec on the left) but abnormal in waveform, being irregular and multiphasic bilaterally (Fig. 5, left). A pneumoencephalogram revealed displacement of the pons forward against the clivus. On September 4, a partially cystic, firm gliomatous mass measuring 4 cm in diameter was removed from the midline of the vermis. When she developed respiratory difficulty the following morning, the left cerebellar tonsil was surgically amputated. On September 21, the early reflexes (9.3 on the right, 9.5 on the left) were slightly less multiphasic. On September 28, she was ambulatory although ataxic. Tracings done on that day (Fig. 5, right) showed that the early reflexes (10.0 msec on the right, 9.3 msec on the left) were normal in

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Fig. 4. Case 2. Tracings made May 22 (left) and July 20 (right). The stimulus was delivered to the supraorbital nerve first on the right (top pair) and then on the left (bottom pair). The reflex responses were simultaneously recorded from the ipsilateral (upper tracing in each pair) and the contralateral (lower tracing in each pair) orbicularis oculi. Note a unilateral early reflex (horizontal brackets) recorded only in the upper tracing and bilateral late reflexes (brackets with broken lines) recorded in both the upper and lower tracings in each pair. The early reflexes were normal (12.0 msec on the right, 11.5 msec on the left) on May 22, and delayed (18.0 msec on the right, 16.0 msec on the left) on July 20 (accurate measurement of early reflexes is difficult with the sweep speed of 10 msec/cm as shown in this figure). The right direct and left consensual late reflexes were slightly delayed (38 msec) when compared to the left direct and right consensual late reflexes (30 msec) on July 20.
Orbicularis oculi reflex with tumors

shape. The late reflexes (30 msec) were normal throughout the course.

Discussion

Studying the orbicularis oculi reflex in patients with acoustic neuroma, Bender, et al., observed delayed early reflex in five of seven patients and suggested it might be useful in diagnosing facial nerve involvement in this disease. Subsequently, we reported that alteration of the orbicularis oculi reflex in cases of cerebellopontine angle tumors might be due to compression of the trigeminal or facial nerves, or both. In fact, our analysis of the direct and consensual late reflexes suggested that both nerves were involved by acoustic neuromas in a majority of patients studied.

The present study demonstrates that the early reflex is consistently delayed or eliminated by intrinsic pontine neoplasms or by extrinsic tumors compressing the pons; the early reflex was also abnormal in two cases of mesencephalic tumors but it was not possible to rule out extension of the lesions into the pons. These and previous studies suggest that alteration of the early reflex is relatively specific for pontine lesions if the trigeminal and facial nerves are intact. The exact pontine pathway of the early reflex is not known. The delay of the early reflex in association with internuclear ophthalmoplegia due to a pontine tumor (Case 1) is of interest in view of similar observations in patients with multiple sclerosis or with brain-stem strokes. The pontine pathway transmitting the early reflex may lie close to the medical longitudinal fasciculus.

The late reflex with its direct and consensual components comparable to the pupillary light reflexes is often useful in determining which part of the reflex is involved. If the affected trigeminal nerve is stimulated, both the direct and consensual late reflexes are delayed. With a lesion of the facial nerve, on the other hand, only the late reflex on the side of the affected facial nerve is delayed; the late reflex simultaneously recorded on the other side is normal regardless

Fig. 5. Case 3. Tracings made before craniotomy (left), and after craniotomy (right). For the top tracing, the stimulus was delivered to the left facial nerve, and the direct motor response (horizontal bars) was recorded from the left orbicularis oculi. For the middle tracing and bottom pair, the stimulus was delivered to the left supraorbital nerve. In the middle tracing, the early reflex (horizontal brackets) was recorded from the left orbicularis oculi with a faster sweep speed (5 msec/cm). In the bottom pair, in addition to the unilateral early reflex (brackets), the bilateral late reflexes (brackets with broken lines) were simultaneously recorded from the left (upper tracing of each pair) and the right (lower tracing) orbicularis oculi with a slower sweep speed (10 msec/cm). The early reflex was normal (8.4 msec) in latency but abnormal in waveform, being very irregular and multiphasic before craniotomy (left). Note a normal waveform of the early reflex with a normal latency (9.3 msec) after craniotomy (right). The direct and the consensual late reflexes were normal throughout the course.
of the side of stimulation. It should be recognized, however, that afferent or efferent delay (or block) of the late reflex does not necessarily implicate the trigeminal or facial nerves since pontine or medullary lesions may produce the same changes in the late reflex. Similarly, patterns compatible with neither afferent nor efferent delay do not necessarily indicate brain-stem lesions unless combined involvement of the trigeminal and facial nerves can be ruled out. The normal or near normal late reflexes seen in most cases of medullary tumors and in some cases of pontine or mesencephalic tumors suggest that the fibers responsible for the late reflex are scattered so diffusely that involvement of some portions of the pathway may not cause detectable change in this reflex.

Conclusions

The orbicularis oculi reflex may be altered by intrinsic brain-stem lesions or by extrinsic compression of the brain stem or trigeminal and facial nerves and appears to be a useful addition to clinical observation in assessment of posterior fossa tumors. As the test is simple to perform and carries no risk to the patient, serial studies of the reflex seem to be of practical value in objectively evaluating changes in brain-stem function.

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References


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