Short report

Intrathecal baclofen and the H-reflex

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SUMMARY  Baclofen was given intrathecally to six patients with severe lower limb spasticity due to
traumatic spinal cord injury. The effects of the drug on spasticity and the ratio between the maximum
amplitude of the H reflex and the M response from the soleus (Hmax/Mmax ratio) were assessed. In
each patient, spasticity was reduced following intrathecal baclofen and in four patients there was a
reduction in the amplitude of the H reflex and Hmax/Mmax ratio. These results suggest that the
Hmax/Mmax ratio may be helpful in establishing optimum drug dosage, particularly when the drug is
used on a chronic basis.

Spasticity may be defined as a motor disorder charac-
terised by a velocity dependent increase in tonic stretch
reflexes (muscle tone) with exaggerated tendon jerks,
resulting from hyperactivity of the stretch reflex.1 It is
beneficial to patients with mild to moderate leg
weakness because increased muscle tone in quadriceps
may improve walking by stiffening the weak knee.2
However, spasticity is of less benefit in patients with
more severe degrees of weakness because it reduces the
flexibility of flail limbs and makes it more difficult for
paraplegic patients to transfer to and from wheel-
chairs.

The most effective pharmacological agent currently
used to reduce spasticity is baclofen, a GABA
derivative. Baclofen appears to act primarily at a
spinal cord level, since spasticity is reduced as effec-
tively in patients with complete spinal cord transec-
tions as in those with incomplete lesions.3 Oral doses
should be limited because of side effects such as
drowsiness and confusion resulting from the central
depressant actions of the drug. These side effects may
occur before the dose is sufficient to produce an
effective concentration at the spinal cord4 and is
probably the main reason for the failure to respond to
oral administration of the drug in 25 to 35% of
patients.5 To overcome this problem an intrathecal
 technique for long term administration has been
developed.5,6 Using this route high local concentra-
tions can be achieved at the spinal cord with small
doses, considerably reducing the concentration to
which the brain is exposed. Better long term control of
spastic symptoms without unwanted central side
effects can be achieved by this method.7,8

In assessing the response to such treatment it would
be useful if an objective measure of spasticity was
available. One technique uses the ratio between the
maximum amplitude H-reflex and M response from
the soleus muscle, the so called Hmax/Mmax ratio.9,10
Patients with lower limb spasticity have a mean value
of this ratio significantly higher than controls.11,12 We
have investigated the effects of intrathecal baclofen on
the H reflex, on the Hmax/Mmax ratio and on
spasticity in functionally complete traumatic spinal
cord lesions.

Material and methods

Six patients with post-traumatic spinal cord lesions were
studied. All were men ranging from 22-42 years (mean: 30.5
years). In each, there was a complete absence of motor and
sensory function below the level of injury (table). The upper
level of the deficit varied from C4 to T11 and the time interval
from the injury ranged from six months to three years (mean
17 2 months). All had bilateral leg spasticity which consider-
ably interfered with their rehabilitation and most were taking
oral antispasticity drugs. All such drugs were withdrawn 24
Intrathecal baclofen and the H-reflex

Table Effects of intrathecal baclofen on spasticity. the H reflex, M response and Hmax/Mmax ratio in patients rendered paraplegic by traumatic spinal cord injury

<table>
<thead>
<tr>
<th>Patient</th>
<th>Lesion level</th>
<th>Baclofen (µg)</th>
<th>Spasticity*</th>
<th>Hamp (µV)</th>
<th>Mamp (µV)</th>
<th>Hmax/Mmax</th>
<th>Spasticity*</th>
<th>Hamp (µV)</th>
<th>Mamp (µV)</th>
<th>Hmax/Mmax</th>
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<tbody>
<tr>
<td>1</td>
<td>T6</td>
<td>25</td>
<td>4</td>
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<tr>
<td>2</td>
<td>T11</td>
<td>50</td>
<td>2</td>
<td>280</td>
<td>720</td>
<td>0.39</td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>T10</td>
<td>100</td>
<td>2</td>
<td>215</td>
<td>380</td>
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<tr>
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<td>C4</td>
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<td>3</td>
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<tr>
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<tr>
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<td>75</td>
<td>4</td>
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<td>3800</td>
<td>0.19</td>
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</table>

*Spasticity was graded according to the Ashworth Scale.12 Hamp–maximum amplitude H response, Mamp–maximum amplitude M response, Hmax/Mmax—ratio of maximum amplitude H reflex to maximum amplitude M response.

hours prior to our investigation. All patients gave informed consent.

The H-reflex and M-response from the right soleus muscle were recorded both before and after baclofen was administered intrathecally. Recording electrodes were placed two cms apart in the mid calf region and the posterior tibial nerve was stimulated in the popliteal fossa using a 0-1 msec second duration square wave pulse at a frequency of 1 Hz. Stimulus intensity was gradually increased to elicit both H and M responses. The H reflex varied in amplitude. Hmax was selected by increasing stimulus intensity until maximum amplitude H responses were obtained. Ten H responses were recorded at this stimulus intensity and the one of greatest amplitude was chosen as Hmax. Mmax was the amplitude of the M response at supramaximal stimulation. Filter settings were 20–10,000 Hz. The recordings were made using a Medelec 92A electromyograph.

Baclofen was administered into the CSF, under sterile conditions, using an intrathecal catheter inserted at L1. It was given in 25 µg aliquots every 20 minutes until clonus at the ankle was abolished and providing the blood pressure remained stable. Repeat electrophysiological testing was performed 20 minutes after the final dose of baclofen had been given. Leg spasticity was graded before the insertion of the intrathecal catheter and again at the end of the study by the same observer, using the Ashworth scale.13

Leg spasticity, judged using a clinical rating scale,12 was reduced in all patients (table).

Discussion

The reduction of spasticity produced by intrathecal baclofen was accompanied by abolition of the H reflex in three patients (50%), and a marked reduction in the amplitude of the H response and Hmax/Mmax ratio in one other. In the two remaining patients, the reduction in Hmax/Mmax ratio occurred due to an increase in Mmax rather than any change in H reflex amplitude. This reflects differences in configuration of the electrodes pre and post treatment and hence no inference can be made about the effects of intrathecal baclofen on the H reflex in these two patients.

Our findings differ somewhat from previous reports concerned with the effects of baclofen on the H reflex. Ashby and White13 reported that oral baclofen had little effect on the H reflex even though spasticity was profoundly reduced. They did comment, however, that some reduction in H reflex was observed with higher oral doses. Birkmayer et al4 reported that IV baclofen reduced the H reflex and spasticity in most patients, although others have found that IV baclofen reduces the H reflex less predictably.15

These results suggest that the effects of baclofen on spasticity and on the H reflex may operate by different mechanisms. The H reflex is a monosynaptic reflex5 whose activity is increased in spasticity.16 Although this reflex contributes to spasticity there are a number of other reflexes which also contribute. One of the most important of these is the muscle stretch reflex. This is part of the fusimotor system which relies on both monosynaptic and polysynaptic connections.17 At low CSF concentrations, such as following oral administration, baclofen may inhibit polysynaptic reflexes in the spinal cord including muscle stretch reflexes, reducing spasticity but may have little effect on monosynaptic reflexes explaining the lack of inhibition of the H reflex. As the CSF and spinal cord
concentration rises following IV or intrathecal administration, monosynaptic reflexes are also suppressed which explains the correlation between $H_{\text{max}}/M_{\text{max}}$ and spasticity observed in this series.13 18 19

The response to intrathecal baclofen can vary quite widely as seen in the variability of drug dosage required to abolish clonus in our patients. Our findings suggest that the $H_{\text{max}}/M_{\text{max}}$ ratio may be useful in evaluating the clinical response and dosage in patients treated with intrathecal baclofen.

We are grateful to Mr J Benfield, Research Registrar, Duke of Cornwall Spinal Treatment Centre, Odstock Hospital, Salisbury.

References

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