POLYSYNAPTIC COMPONENTS OF THE EARLY SOMATO-SYMPATHETIC REFLEX RESPONSE IN LUMBAR WHITE RAMI

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The second and third components of the somato-sympathetic reflex discharge in the lumbar white rami were investigated in anesthetized cats. Both components, under different experimental conditions, may undergo changes that are: parallel, not parallel, or actually opposite in direction to those in components of the propriospinal wave of the somato-somatic reflex. This suggests that the interneuronal apparatus of both types of reflexes may include common and separate components. It is postulated that the separate components of the somato-sympathetic reflex may be formed by discharges of sympathetic preganglionic neurons whose axons conduct at different velocities. On the basis of calculations of the central delay time it is concluded that the second component is formed by discharges of lateral horn neurons and the third component by neurons with axons conducting excitation at less than 1.5 m/sec, found in the lateral part of the intermediate zone.

INTRODUCTION

The writers showed earlier [7] that the early somato-sympathetic reflex responses (ER) arising in the lumbar white rami communicantes (WRC) to stimulation of segmental somatic nerves consists of three typical components. The study of the component with the shortest latency (ER-I) yielded facts indicating that this component is probably monosynaptic. In the present investigation the properties of the second (ER-II) and third (ER-III) polysynaptic components of the early somato-sympathetic reflex responses are examined. It was assumed that data on the structure of the central part of ER-II and ER-III could be obtained by comparing them with the corresponding propriospinal (PS) components of the somato-somatic reflex, which has common afferent links with ER-II and ER-III.

An attempt also was made to determine which sympathetic preganglionic neurons (SPN) can participate in the formation of ER-II and ER-III.

EXPERIMENTAL METHOD

Experiments were carried out on 30 cats. The techniques were described earlier [5, 6, 7]. In some experiments, simultaneously with recording the responses in WCR to stimulation of the neighboring nerves, reflex discharges were recorded in the segmental nerve corresponding to the WRC. In two animals, in the course of the experiments the spinal cord was divided in segment TII after preliminary infiltration with procaine. The temporary fall of blood pressure thereby produced was reversed by administration of adrenalin solution by intravenous drip.

RESULTS

Properties of ER-II and ER-III. The basic characteristics of ER-II and ER-III are shown in Table 1. Data on ER-I are also given for comparison. In 76% of cases two or three separate waves, designated ER-IIa, ER-IIb, and ER-IIc could be distinguished in ER-II. It was difficult to determine the time of appearance of ER-IIa exactly in the seven cases in which ER-I consisted of several discharges and continued...
TABLE 1. Characteristics of Early Somato-Sympathetic Reflex Components

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ER-I</th>
<th>ER-II</th>
<th>ER-III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latent period, msec</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>31</td>
<td>62</td>
<td>47</td>
</tr>
<tr>
<td>2</td>
<td>3.2–8.5</td>
<td>6.8–15</td>
<td>9–20</td>
</tr>
<tr>
<td>3</td>
<td>48.3 ± 0.15</td>
<td>9.64 ± 0.23</td>
<td>13.85 ± 0.43</td>
</tr>
<tr>
<td>Direction, msec</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>31</td>
<td>62</td>
<td>47</td>
</tr>
<tr>
<td>2</td>
<td>0.5–4.5</td>
<td>1.4–14</td>
<td>2–9</td>
</tr>
<tr>
<td>3</td>
<td>2.02 ± 0.023</td>
<td>5.20 ± 0.38</td>
<td>4.24 ± 0.32</td>
</tr>
<tr>
<td>Amplitude, μV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>31</td>
<td>53</td>
<td>41</td>
</tr>
<tr>
<td>2</td>
<td>2–18</td>
<td>3–45</td>
<td>3–32</td>
</tr>
<tr>
<td>3</td>
<td>5.55 ± 0.83</td>
<td>13.54 ± 1.09</td>
<td>12.34 ± 1.01</td>
</tr>
<tr>
<td>Threshold, conv. units</td>
<td>12</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>0.5–13</td>
<td>1</td>
<td>1–2</td>
</tr>
<tr>
<td>3</td>
<td>3.35 ± 1.16</td>
<td>1</td>
<td>1.33 ± 0.12</td>
</tr>
</tbody>
</table>

Legend. 1) Number of observations, 2) limits of waves, 3) mean values.

without a clear gap into ER-IIa [7]. The same was true also of ER-III, which was not always clearly de-
marcated from ER-IIc.

The mean latent period of ER-IIa, 9.64 ± 0.23 msec, indisputably pointed to the polysynaptic nature of
this and the later components of ER. This was shown by the great variability of their latent period, am-
plitude, and duration in responses recorded successively and evoked in a very slow rhythm (0.2 per second).
The latent period of ER-IIa agreed closely with the latent period of ER measured by other workers [11, 15,
16, 30]. Since the amplitude of ER-IIa + ER-IIb) was about three times greater than the amplitude of ER-
and ER-III, this component was the most conspicuous and it is usually regarded as the chief component [2],
or at times the only expression of the ER, more especially because ER-II had the lowest threshold of ap-
pearance (Table 1).

With an increase in the strength of stimulation of the segmental nerve sufficient to activate C fibers,
a further component, consisting of several waves, appeared in the corresponding WRC after ER-III (Fig.
1). This was shown to be the result of antidromic activation of sympathetic postganglionic fibers running
into the somatic nerve from the gray ramus, which is sometimes closely connected with WRC [28].

Let us compare ER-II and ER-III with the individual propriospinal components (PS) of the somato-
somatic reflex. Although some of the features distinguishing the somato-somatic reflex, including its
spino-bulbo-spinal (SBS) wave [32], have been studied in sufficient detail, no full descriptions of the PS-
wave have yet been given. It will be clear from Fig. 1A that this wave is nonhomogeneous. Three com-
ponents can be distinguished in it. The first component, PS-I, had the shortest threshold and a latent
period of 3.6–4.0 msec. Its appearance in the somatic nerve was not accompanied by the appearance of ER
in the WRC. PS-I merged directly with PS-II and the line between the two components could be found only
from the inflection on the leading edge of the PS wave. The threshold of appearance of the SBS wave was
close to the threshold of PS-I. With an increase in the strength of stimulation of the segmental nerve by
about 1.5 times a PS-II appeared after a latent period of 4.0–6.2 msec. Meanwhile, ER-II appeared in WRC.
Since both PS-II and ER-II were the most clearly marked components of PS and ER, it was possible to ob-
serve that their amplitude increased parallel with an increase in the strength of stimulation (Fig. 1C). With
a further increase in the strength of stimulation by 2–10 times, desynchronized waves appeared on the de-
scending phase of PS-II with a latent period of 8–9 msec, described as PS-III. This coincided with the ap-
pearance of ER-III and ER-I in WRC.

It was easy to see that the latent periods of ER-III and of the SBS wave of the somato-somatic reflex
were similar (about 20 msec). After complete division of the spinal cord at the level T11, no change took
place in the amplitude of ER-III, although under these circumstances the SBS wave disappeared. Conse-
quently, ER-III is closed at the spinal level. Immediately after division of the spinal cord ER was not in-
hibited, as other workers have observed [6]. The amplitude of ER was not increased for 2 h after division,
as has also been observed [2, 23, 39].

The thresholds of appearance of the individual components of the PS-wave of the somato-somatic re-
flex thus coincided with the thresholds for the early somato-sympathetic responses.