Introduction

The anterior cingulate cortex (ACC) is known to be involved in processing of nociceptive information. However, the transmission pathway between ACC and peripheral noxious stimulation is still unclear. In the present study, electrophysiological properties of neurons in the ACC were investigated when peripheral noxious stimulations were applied.

Materials and Methods

Preparation of Animals

14 male Sprague Dawley rats (body weight 250-350 g) were initially anesthetized with 4% halothane (in 100% O₂). After tracheal catheterization, the animals were maintained in 0.5-1% halothane and paralyzed with 10% gallamine triethiodide and then artificially ventilated. Craniotomy was performed for electrophysiological recording.

Peripheral Noxious Stimuli

High intensity electrical current was delivered to the sciatic nerve as electrical stimuli. Noxious pinches at the hindpaw and tail were applied as mechanical stimuli. Both electrical and mechanical stimuli were applied ipsilaterally and contralaterally.

Recording of Evoked Field Potentials and Unit Activities of ACC

Glass micropipette filled with 3N NaCl was used to record the evoked field potentials and unit activities in the ACC and somatosensory cortex. The impedance of micropipette varies from 1 to 7 Mohm.

Data Analysis

The characteristics of neuron responses were indicated by unit activity and field potentials. A post-stimulus histogram in unit recording was the summation of spikes in a 2 minute recording time according to the time after stimulation. A field potential was a average waveform in a 2 minutes recording time. Interspike intervals were the distributions of different time intervals of spikes. All analysis were done by Spike2 4® of Cambridge Electronic Design.

Result

Fig.1. a. Typical responses evoked by electrical stimuli in the ACC. The upper graph is a post-stimulation histogram, and the arrow head indicate a cluster of spikes as response, 200ms after stimulus, in this unit, in this unit. The lower is a average of field potential recorded from the same unit. A negative component, 18ms after stimulus, is indicated by another arrow head. The dotted line represent the time when stimuli were applied.

Fig.1. b. Typical responses evoked by electrical stimuli in the somatosensory cortex. Comparing with the response in ACC, the response in somatosensory cortex was more earlier evoked at the time of 25ms after stimulus. The responses in both post-stimulation histogram and field potential were evoked at the same time. Represent that the unit is responded to stimuli.

Fig.2. Noxious mechanical stimuli were applied to different part of rats. The black bars indicate the time when stimuli were applied. The units in ACC had excitatory response to left hindpaw pinch, but had inhibitory response to tail and right hindpaw pinches.

Fig.3. The morphological distribution of active units in the ACC. The open circle represents a unit with unilateral excitatory response, a solid circle represents a unit with bilateral excitatory response, and unit with inhibitory response is shown as open square. (a) The units responded to electrical stimuli (n=50) (b) The units responded to mechanical stimuli (n=9).

Table 1. The number and percentage of different types of unit. 108 units were recorded in 14 rats. The active units were sorted by types of stimulation, and types of response.

<table>
<thead>
<tr>
<th>Stimulation</th>
<th>Response</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Intensity Electrical stimulation</td>
<td>Excitatory</td>
<td>31</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>Inhibitory</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Nociceptive Mechanical stimulation</td>
<td>Excitatory</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Inhibitory</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>9</td>
<td>100</td>
</tr>
</tbody>
</table>

Conclusion

Present results demonstrated that there are nociceptive neurons in the ACC. The properties of the late of long lasting and bilateral evoked responses indicated that the ACC neurons may play a role in the affective aspect of nociceptive information processing.

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Reference

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