THE PHASE OF STRYCHNINE SPIKE IN CAT CEREBRAL CORTEX

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It has been assumed by many workers that nerve cells in the presence of adequate quantity of strychnine would augment their spontaneous discharge or would discharge synchronously (1) (2) (3). And characteristic spikes are observable not only in applied locus, but also in the part connected to there, when strychnine directly applied to cerebral cortex (1).

For us who have an interest in each phase of three components of a strychnine spike, clarifying of the phase in origination by simultaneous record of surface and various intracortical region is the object of our present report.

METHODS

The spike in this report, was recorded at precentral, postcentral, lateral, or suprasylvian gyrus of exposed cortex of cat anesthetized by urethane. Strychnine solution of 1% was always applied by use of 2 x 2 mm filter paper. This filter paper soaked with strychnine solution was placed on the desired location of cerebral cortex. Perhaps the diffusion of this solution on filter paper was kept in minimum in this experiment. Copper wire insulated with enamel except tip was used as recording electrode. The tip of this electrode was 50-100 μ in diameter. The first electrode was placed on the surface of cortex, and second or sometimes third electrode was inserted into various depths under cortical surface electrode. They were operated by manipulator. Indifferent electrode was situated upon the tip of nose.

Electrodes and schematic cytoarchitecture of the precentral gyrus. e_I—surface electrode, e_{II}—electrode placing at every intracortical layer, f.p.—filter paper soaked with strychnine solution, c.c.—all layers of cerebral cortex, w.m.—white matter.

The spike potentials were illustrated by the cathode ray oscillographs and inkwriters through six channels amplifier of EEG. Surface potential and intracortical potential were simultaneously recorded with those apparatus.

Figure 2.

Strychnine spikes recorded at various cortical depths in mm, as indicated left side of each trace. The amplitude of 60 cycle waves indicates 0.2 mv.

RESULTS

1. Surface record of strychnine spike

In the surface recording, the electrical discharge of the cerebral cortex produced by topical application of strychnine to the cortical surface is characterized by a powerful surface-negative wave preceded by a small and followed by a prolonged positive deflection as shown in Fig. 2 a. The size of the spike was markedly greater at the advanced stage of the strychnine action than at the beginning, and this growth in size of the spike seemed to the increase of degree of the poisoning. In this state that the negative component has an amplitude of 4 or 5 mV which seems to be reached to the full strength, the spike not only becomes greater in size, but also tends to show irregular shape which has multiple peaks. The average duration of each phase of strychnine spike was as follows, the first positive wave was ca. 35 msec, the second negative wave was ca. 80 msec and the last prolonged positive wave was ca. 150 msec respectively. The synchronous discharge of strychninized cortical neurones began to appear at about 3 minutes after application of 1% solution.

2. Intracortical record of strychnine spike

Strychnine spike in various cortical depths obtained by intracortical recording differs in polarity, magnitude or duration etc. from that of surface one, as shown in Fig. 2 b, c, d. When a recording electrode was situated in about 0.3 mm under the surface of precentral gyrus, the first surface positive component became considerably smaller than that of surface, however, there was no remarkable change in second and

third component.

In the depth of 0.5—1 mm, the first surface positive phase did not frequently appear, and the negative one had larger amplitude and longer duration than that of surface one.

When the electrode reached to deeper layer of cortex (more than 1 mm from surface), the polarity of each component perfectly reversed as Fig. 2 d.

In the white matter (Fig. 2 e), the phase of spike was similar to that of deeper cortex, but the magnitude of each component was declined in proportion to the degree of the depth of electrode.

These phenomena were observable not only in the precentral gyrus, but also in other gyri as examined by us, however, these parts did not demonstrate as clear as precentral gyrus. Moreover, these phenomena were observed more clearly at the beginning of strychnine effect than the time near end of effect.

DISCUSSION

In the present investigation, when the electrode situated at the depth of about 0.3 mm from cortical surface, the initial positive component became smaller than that in surface recording. And at about 0.5—1 mm depth this did not occur, moreover at the depth of more than 1.0 mm it appeared again reversely in the polarity of all components.

It was studied by Adrian (1936) that the pure surface positive wave set up by stimulation at 1.5—2 mm deep to the cortical surface (4), and because the first component of strychnine spike from the surface is positive deflection, it is conceivable that the cortical excitation of spike will initiate at deeper part.

The second negative phase will be occurred by the excitation of relative superficial neurones and the final positive phase may be due to spreading of activity toward out or deep.

Since cortical excitation restricted in certain area being apart from recording electrode will be recorded with positive potential, each phase of a strychnine spike will have focus regard to layer of cortex.

SUMMARY

We investigated the phase of strychnine spike in cat cortex by use of simultaneous recording of surface potential and intracortical potential and obtained the results as follows.

1. Initial surface positive component did not appear at relative superficial layer of

cerebral cortex.

2. In records by electrode within deeper layer, each polarity of components of a spike perfectly reversed.

3. In the white matter, polarity of spike was similar to that of deep layer, however, magnitude decreased in proportion to the depth.

4. From these results, it is supposed that the initial surface positive phase is synchronous discharge of deep neurones, the second large negative phase is that of superficial neurones transmitted from deep ones, and the third is more widespread activity of excitation in layer of second component.

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