ROLE OF THE CORPUS CALLOSUM IN TRANSMISSION OF STRYCHNINE EXCITATION FROM THE CORTEX OF ONE HEMISPHERE TO THE OTHER

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Experiments on cats and rabbits immobilized with lysthenon showed that division of the corpus callosum completely prevents transmission of strychnine discharges from one hemisphere to the other. It was also found that the temporal region of one hemisphere is connected with the symmetrical region of the opposite hemisphere through fibers of the posterior two-thirds of the corpus callosum.

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It is believed [1, 5, 11] that the transmission of strychnine paroxysmal discharges from one hemisphere to the other takes place only via commissural fibers of the corpus callosum. Other workers [6, 7] do not share this view and assert that after division of the corpus callosum the transmission of strychnine discharges from the cortex of one hemisphere to the other does not disappear but takes place mainly through structures lying at the level of the mesencephalon, and through more rostral structures.

The object of the present investigation was to make a detailed study of the pathways along which strychnine excitation is transmitted from the temporal cortex of one hemisphere to the other.

EXPERIMENTAL METHOD

Experiments were carried out on 50 adult cats and ten rabbits. Preparations for the experiment (tracheotomy, wide craniotomy) were carried out under superficial ether anesthesia. The experiment was performed on unanesthetized animals immobilized with lysthenon, using artificial respiration. Potentials were recorded with bipolar silver electrodes. The electroencepahlogram was recorded with a 4-channel ink-writing electroencephalograph. The temporal cortex of one hemisphere (in most cases the middle parts of the suprasylvian and ectosylvian gyri) was stimulated by application of filter paper measuring from 1 × 1 to 5 × 5 mm, soaked with 0.5-1% strychnine nitrate solution, to its surface. Strychnine was applied to other areas of the cortex only in a few experiments. A short time after application, strychnine discharges appeared on the side of stimulation and also on the opposite side. To exclude any effect of operative trauma, the experiments were carried out at different times after division of the corpus callosum or parts of it, sometimes 3-7 h after the operation. The amplitude of the paroxysmal discharges at the focus of strychninization did not exceed 300-500 μV. The brain of the animals undergoing the operation was subjected to a detailed morphological examination.*

EXPERIMENTAL RESULTS

The middle part of the suprasylvian gyrus is very rich in association and callosal fibers, and when treated with strychnine its epileptiform discharges very soon appear in both hemispheres [8, 12]. In our experiments, when strychnine was applied to the middle part of the suprasylvian gyrus paroxysmal discharges were clearly recorded both on the side of strychninization and in the opposite hemisphere. In every case after complete division of the corpus callosum transmission of paroxysmal discharges were clearly recorded both on the side of strychninization and in the opposite hemisphere. In every case after complete division

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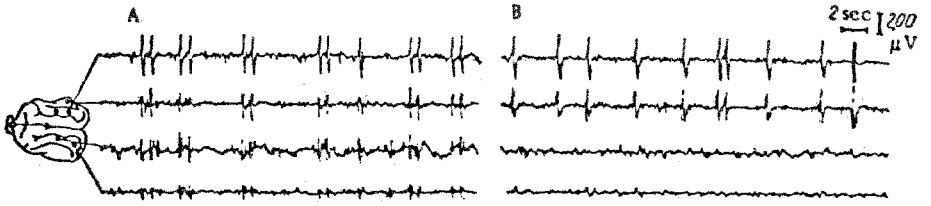

Fig. 1. Effect of complete division of corpus callosum on transmission of strychnine discharges from corpus of one hemisphere to the other. A) Before complete division of corpus callosum paroxysmal discharges are recorded both on the side of strychninization and on the opposite side; the point of strychninization is denoted by a dot in the middle part of the right suprasylvian gyrus; B) after complete division of the corpus callosum transmission of strychnine discharges to the opposite side disappeared.

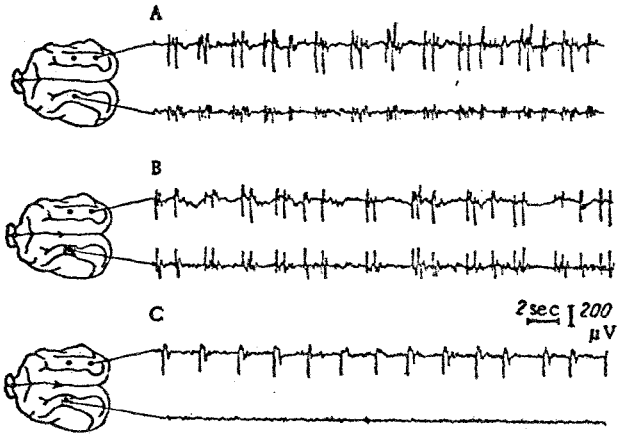

Fig. 2. Effect of division of corpus callosum on transmission of strychnine discharges from cortex of one hemisphere to the other after application of strychnine solutions in a subconvulsive dose (0.05%) to the symmetrical, receiving area. A) Before application of strychnine solution to receiving area; B) increase in amplitude of strychnine discharges in receiving area after application of strychnine solution in subconvulsive dose (area of application shaded); C) after division of corpus callosum transmission of strychnine discharges to opposite hemisphere disappears.

of the corpus callosum transmission of paroxysmal discharges from the temporal cortex of one hemisphere to the other stopped completely and did not reappear in the future (Fig. 1). In another variant of the experiments, we attempted to increase the excitability of the receiving area symmetrical to the strychninized point by treating its surface with a subconvulsant dose of strychnine (0.05%). This procedure considerably strengthened the strychnine discharges in the "mirror" focus. However, despite this increase in excitability of the receiving area, after complete division of the corpus callosum paroxysmal discharges were not transmitted from the strychninized focus to the receiving area (Fig. 2).

To increase the general level of excitability of the central nervous system after complete division of the corpus callosum, we gave the animals an intraperitoneal injection of a subconvulsive dose of strychnine (0.15-0.20 mg/kg). In addition, in individual experiments the reticular formation was activated by application of a nociceptive stimulus to the animal's hind limb: one paw was dipped in hot water (55-70°). Despite these procedures, after complete division of the corpus callosum the transmission of strychnine discharges from one hemisphere to the other no longer took place.

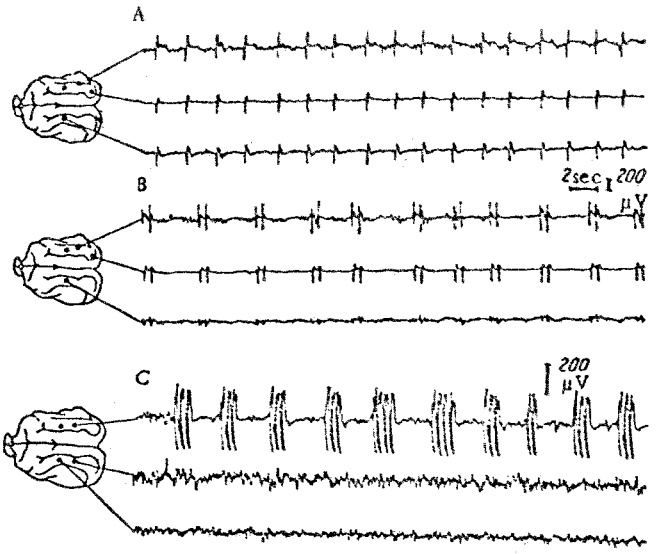

Fig. 3. Effect of partial division of corpus callosum on transmission of strychnine discharges from cortex of one hemisphere to the other (strychninized focus produced in middle part of suprasylvian gyrus).

In the next variant of the experiments, the strychninized focus and other parts of the cortex of that hemisphere were isolated by circular vertical incisions. The incision passed through the whole thickness of the cortex and white matter, i.e., all association and commissural fibers were divided. This isolation of the strychninized focus prevented the spread of paroxysmal discharges across the incision. Hence, all the experimental data described above indicate that irradiation of strychnine excitation within the cortex of one hemisphere takes place along association fibers, while the transmission of paroxysmal discharges from the cortex of one hemisphere to the other takes place entirely through fibers of the corpus callosum. Hence, our results do not confirm the conclusions drawn by Shelikhov [6] and Shelikhov and Rogacheva [7], who assert that after complete division of the corpus callosum the transmission of strychnine discharges from one hemisphere to the other does not disappear.

As our investigations showed, only a very small part of the corpus callosum need be left undivided to ensure transmission of strychnine discharges from one hemisphere to the other. We also observed cases when only a very thin strip of fibers in the posterior part of the corpus callosum remained undivided. In these cases the transmission of strychnine discharges to the opposite side still continued, but the amplitude of the paroxysmal discharges in the receiving area was considerably reduced (Fig. 3A, B). These facts clearly demonstrate the great importance of the quality of division of the corpus callosum fibers. It may be that in the experiments of Shelikhov and Rogacheva some fibers of the corpus callosum remained undivided and these were able to transmit strychnine discharges.

In another series of experiments we attempted to define the role of individual parts of the corpus callosum in the transmission of strychnine discharges from the cortex of one hemisphere to the other. These experiments showed that division of the middle part of the corpus callosum only does not prevent the transmission of strychnine discharges to the opposite side. Division of the posterior part of the corpus callosum only likewise did not block transmission. Transmission of strychnine discharges from the temporal cortex of one hemisphere to the other stopped in our experiments only after simultaneous division of the middle and posterior parts of the corpus callosum (Fig. 3C). However, when in the same experiments, i.e., after division of the posterior two-thirds of the corpus callosum, strychnine was applied to the sensorimotor cortex, paroxysmal discharges were transmitted to the symmetrical region. Hence, these experiments showed that the temporal areas of the cortex of one hemisphere are connected to the symmetrical areas of the opposite hemisphere through fibers in the posterior two-thirds of the corpus callosum.

Naturally we do not by any means deny the possibility that connections between the hemispheres may take place via extracallosal pathways after complete division of the corpus callosum. Evidence of this possibility is given by experimental results obtained recently by means of other techniques [2-4, 9, 10, 13-15].

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