In experiments on cats, we investigated focal potentials of Clarke's column neurons and discharges of individual neurons recorded extracellularly. An ultrasonic scalpel was used to remove the part of the spinal cord between Th13 and L3, and an electrode was inserted into the face of the caudal segment of the spinal cord along the axis of Clarke's column. Orthodromic excitation of Clarke's column neurons was evoked by stimulating cut nerves of the ipsilateral extremity; antidromic excitation was evoked by stimulating the dorsolateral funiculus, which was preliminarily separated from the removed portion of the spinal cord. It was found that the orthodromic potential, antidromic potential, and discharges are distinctly registered when the method of electrode insertion is used, whereas they were not recorded when the microelectrodes were sunk into the dorsal surface in these experiments. It is demonstrated that orthodromic and antidromic focal potentials of Clarke's column neurons are similar to motoneuron focal potentials with respect to time characteristics. Inversion of the charge sign was recorded with the approach of the microelectrode's tip to the soma of Clarke's column neurons. It is hypothesized that the success of recording focal potentials and extracellular discharges of Clarke's column neurons resulted from the fact that the orientation of dendrites of these cells matches the direction of microelectrode movement. The slender portion of the microelectrode penetrates the interdendritic space, where tension of the extracellular field is the greatest; it then moves through this space to reach the soma.

INTRODUCTION

It has been recorded in electrophysiological research on Clarke's column neurons (neurons of the dorsal spinocerebellar tract – DSCT) that a focal potential is not registered in the vicinity of these nerve
Fig. 2. Focal potentials in the vicinity of Clarke's column during stimulation of different nerves of the posterior extremity. Here and in the figures to follow, the upper oscillogram represents recording from the dorsal surface of the spinal cord at the level of L₅, and the lower one represents recording from Clarke's column at the level of L₃. Q) M. quadriceps; H) m. semitendinosus + semimembranosus (hamstring); G) m. gastrocnemius; FDL) m. flexor digitorum longus; Per.) n. peroneus; Tib.) n. tibialis; Sur.) n. suralis.

Fig. 3. Focal potentials evoked by stimulation of the n. quadriceps recorded during movement of the microelectrode along the axis of Clarke's column. Figures indicate depth of microelectrode penetration from the plane of transection (in mm). The designation "vertically" means that recording from Clarke's column was achieved with a microelectrode sunk vertically into the spinal cord through its dorsal surface. In this experiment, the electrode was sunk into the spinal cord at a point 2.5 mm behind the dorsal rim of the transection.

cells, although the presynaptic wave and postsynaptic response arise fairly synchronously during stimulation of homogeneous afferent fibers [7]. The absence of a focal potential seems all the more remarkable in that amplitude and duration of EPSP of DSCT neurons are greater than those of motoneuron EPSP, and (in contrast to the latter) do not fall after the peak [8, 9].

There can be no doubt that transmembrane currents should create an alternating extracellular field in the vicinity of DSCT neurons. It can only be presumed that the difficulties involved in detecting the focal potential are associated with the peculiar configuration and small dimensions of the field; it is possible that the latter matches the configuration of DSCT neurons, which (together with their dendrites) are greatly elongated along the axis of the spinal cord [19]. It is apparently for this reason that extracellular recording of the activity of individual DSCT neurons is so difficult and possible only when the microelectrode comes in direct contact with their membrane [11].

At the same time, study of focal potentials in Clarke's column and extracellular potentials of DSCT neurons would be of considerable interest, since intracellular investigation of these elements is associated with considerable difficulties (low probability of microelectrode entrance, considerable susceptibility of the cells to injury).

Taking these facts into account, we used a method involving insertion of a microelectrode along the axis of Clarke's column to register the focal potential of DSCT neurons. According to our assumptions, such a method should increase the probability of achieving contact between the microelectrode's tip and DSCT neurons and the extracellular field formed by them.

METHOD

Experiments were carried out on cats anesthetized with a mixture of nembutal and chloralose (15 and 45 mg/kg respectively, intraperitoneal injection). Laminectomy was carried out at the levels of Th₁₂-L₃.