Modulation During Sleep of the Spino-Cerebellar Evoked Potentials[1]

During the rapid eye movements (REM), which characterize the desynchronized phase of sleep, the somatosensory input is actively blocked at the level of the dorsal column nuclei by mechanisms of presynaptic and postsynaptic inhibition[2]. The aim of the present experiments was to find out whether the transmission of exteroceptive and proprioceptive volleys through the spino-cerebellar pathways is affected by sleep, as has been found for the transmission of somatosensory volleys through the lemniscal pathway.

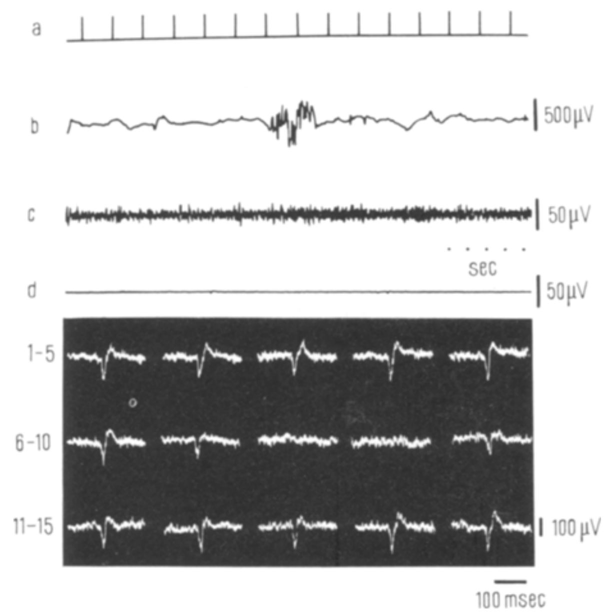
Methods. The modulation during physiological sleep of the cerebellar-evoked potentials elicited by single shock stimulation of hindlimb nerves was investigated in 12 unrestrained, unanesthetized cats. The electroencephalogram (EEG), the electromyogram of the posterior cervical muscles (EMG), and the electro-oculogram (EOG) were recorded through chronically implanted electrodes. Collar-type electrodes were applied to the gastrocnemius nerves or to the tibial and/or the deep peroneal nerve of both sides. The nerves were tied distally to the stimulating electrodes, while a bipolar recording electrode was introduced in the hindlimb region of the cerebellar cortex of the anterior lobe, between the vermal and the intermediate regions. The experiments started 1–2 days after the implantation of the electrodes. The hindlimb nerves were stimulated with single rectangular pulses, 0.05–0.2 msec in duration, at the repetition rate of 1 every 1.5–2.0 sec. The cerebellar-evoked potentials were then recorded during different episodes of sleep and wakefulness.

Results. Preliminary observations obtained by recording the ingoing volley have shown that the positive-negative evoked potentials elicited from the cerebellar cortex of the anterior lobe on single shock stimulation of peripheral nerves are due to stimulation of group II and III muscular and cutaneous afferents. The contribution of the group I*a* muscular afferent volleys to the positive wave is almost negligible[3].

The potentials recorded from the cerebellar cortex of the anterior lobe on stimulation of hindlimb nerves were not modified during transition from relaxed wakefulness to synchronized sleep, nor was any significant difference observed between spindles and interspindle lulls. During desynchronized sleep, the amplitude of the cerebellar-evoked potentials was also not affected when ocular movements were absent. A striking depression of the cerebellar-evoked potentials occurred when the bursts of REM were intense, and actually during large bursts of REM the cerebellar-evoked potentials were completely abolished (Figure). When the bursts of REM were small, indeed even when they were represented by isolated ocular movements, the spino-cerebellar potentials appeared clearly reduced in amplitude.

The present experiments show that during the desynchronized phase of sleep there is a striking depression of the cerebellar-evoked potentials. This depression, similar to that which involves the orthodromic lemniscal response on stimulation of peripheral nerves, is related to the mechanisms which are also responsible for the ocular movements. The amount of this depression, however, is greater than that affecting the lemniscal response, since (1) the cerebellar-evoked potentials are completely abolished during the large bursts of REM and not simply reduced in amplitude, as found for the lemniscal responses[2], and (2) the spino-cerebellar evoked potentials are clearly depressed even during the isolated ocular movements, while the orthodromic lemniscal response is not changed in this condition.

The modulation of the cerebellar-evoked potentials during desynchronized sleep is probably due to a phasic inhibitory control of transmission of group II and III afferent volleys through the channels which transmit the spinal information from the hindlimb to the cerebellum. The dorsal and ventral spino-cerebellar pathways are the main but not the exclusive pathways involved in the responses.



Phasic depression of the spino-cerebellar evoked potentials elicited by hindlimb nerve stimulation during a burst of REM of desynchronized sleep. (a) Signals of stimuli applied to the left tibial nerve (0.2 msec duration, 8 times the threshold for the cerebellar evoked potential); (b) EOG; (c) EEG; (d) EMG of the posterior cervical muscles (inkwriter). The 15 CRO responses of the left cerebellar vermis of the anterior lobe to shocks applied to the ipsilateral tibial nerve were recorded before (1–5), during (6–10) and after (1–15) the outburst of REM. The responses 8 and 9 recorded during and soon after the outburst are completely abolished.

Riassunto. Nel sonno desincronizzato si osserva una depressione fasica delle risposte cerebellari evocate dalla stimolazione di nervi dell'arto posteriore. Questa depressione ipnica della risposta spinale cerebellare è completa durante i REM, ma si manifesta, sia pure parzialmente, durante i movimenti oculari isolati che compaiono negli intervalli tra i tipici REM.

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[3] O. Pompeiano and J. E. Swett, Archo ital. Biol. *101*, 584 (1963).