Clinical and experimental observations have demonstrated a relationship between epilepsy and sleep. During slow wave sleep (SWS), facilitation of the epileptic activity has been observed, as well as an inhibition of this activity during the rapid eye movement (REM) stage. On the other hand, during epileptic seizures, sleep inhibition is manifest, but when epileptic activity is present without seizures, an increase in cortical synchronization is encountered. Vagus nerve electrical stimulation (VNS) induces synchronization or desynchronization of cortical activity depending on the stimulation parameters. We have described an inhibition of generalized convulsive activity induced either by electrical (kindling) or chemical (penicillin) stimulation of the temporal lobe amygdala. It has also been demonstrated that VNS induces ponto-geniculo-occipital activity thus suggesting that VNS exerts an influence on epilepsy and sleep. The aim of this study was to analyze the effect of chronic electrical stimulation of the vagus nerve on epilepsy-induced changes in the temporal organization of sleep and wakefulness stages. Ten male cats were stereotaxically implanted to record conventional sleep. In addition, a bipolar stainless steel electrode bound to a cannula was directed to the central nucleus of the temporal lobe amygdala. Finally, a bipolar hook stainless steel electrode was fixed on the left vagus nerve at the level of the larynx. One microliter of saline solution containing 100 IU of sodium penicillin G (Pn) was injected into the amygdala to induce an epileptic state. The left vagus nerve was stimulated with 30-s impulses in an hour, five times a day; subsequently brain electrical activity was recorded for 8 hours. The Pn injection elicited interictal spikes and changes in the temporal organization of sleep and wakefulness stages. The temporal organization of these stages exhibited the following variations: a) increase in the number of phases during wakefulness, b) increment in the number of phases during SWS-I and a diminution in the mean duration of this phase, c) SWS-II total time was increased as well as its percentage, d) latency of REM sleep increased, whereas the number of phases and the total time of this phase decreased. VNS in presence of Pn produced the following changes: a) increase in the latency of the appearance of spikes in 88%, and b) reduction of spike frequency in 40%. With regard to the temporal organization of sleep and wakefulness stages, we observed: a) decrease in the number and total time of SWS-I and SWS-II phases and b) diminution in the latency of onset of the first REM sleep. VNS reverted REM sleep inhibition induced by epilepsy, as well as caused increase in wakefulness and decrease in cortical synchronization and interictal epileptic activity. These effects suggest inactivation of areas that induce REM sleep and also of areas that induce the generalization of epileptic activity localized in brain stem, which send their projections to the anterior brain. With respect to the decrease in both cortical synchronization and somnolence, this
might be due to the inhibition, via the solitary tract and locus coeruleus nuclei, of thalamic areas (reticular nucleus), which generate the cortical synchronization. The increase in wakefulness may be due to VNS activation of the basalis nucleus (this pathway originates in the brain stem), which is a system that regulates awake and attention behaviors by its projections, which traverse the thalamic nuclei and connect to the cerebral cortex.

**Keywords**

Vagus nerve, amygdala, penicillin, epilepsy, sleep.