Interictal EEG pattern in rabbit penicillin epilepsy

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The effects of Na-penicillin G (1,000,000 I.U./kg i.v.) were studied in 28 rabbits implanted with surface and deep electrodes in the medial (mT) and lateral (lT) nuclei of the thalamus and in the cornu Ammonis dorsalis (CAD). Attention was focused on interictal spike activity, cortical spindle activity and spikes-spindles relationship.

A multifocal interictal EEG pattern, represented by cortical and thalamic spikes, was observed in 20 animals. A clear association between cortical spikes and spindles occurred almost constantly. Moreover a statistically significant increase in the average duration of spindles without changes in the average frequency was noticed. Seizure discharges had always a focal start and secondary generalization.

The EEG features of parenteral penicillin epilepsy in the rabbit appeared to be more similar to those of the rat than to those of the cat.

The spindle activity changes and the paroxysmal spike activity can be interpreted as two independent penicillin induced features appearing during raised cortical excitability periods.

Key-Words: Rabbit penicillin epilepsy — spikes — spindles

Introduction

The electroencephalographic features observed after penicillin injection in cats and rats have been the subject of several published reports [1, 3, 4, 5, 13, 14].

Recently De Feo et al [2] described generalized or focal epileptic patterns in penicillin treated rabbits implanted with surface or deep electrodes respectively but they did not explore the thalamic nuclei or study cortical spindle activity.

In a previous paper [12] we examined the electrocorticographic effects of parenteral acute penicillin administration in rabbits. The presence of interictal generalized spikes and polyspikes and an increase in the EEG spindle activity were observed, as well as a clear temporal relation between penicillin spikes and spontaneous spindles. Electrical activity from deep structures was not recorded.

Aim of this work is the study of the EEG features induced by acute parenteral penicillin in rabbits implanted, with deep electrodes (hippocampus and thalamus), with special reference to thalamocortical interaction and spikes-spindles relationship.

Methods

Acute experiments were conducted on 28 adult male New Zealand rabbits weighing 2.5 to 3.5 kg (5 to 6 months of age). The animals were immobilized in a special container [7]. After local anesthesia by subcutaneous infiltration with carbocaine, a small craniotomy (10 × 10 mm) was carried in the left posterior corner of the coronal and sagittal suture intersection. No general anesthesia was given. Six platinum needle electrodes (0.3 mm bare tip and 3 mm apart) fixed on a plate were implanted through the craniotomy: two in the medial (mT) and two in the lateral nuclei (lT).
thalamus and two in the cornu Ammonis dorsalis (CAD), according to the stereotaxic method of Monnier and Gangloff [10]. Four surface silver screw electrodes (10 × 1 mm) were also placed on the skull over the sensorimotor cortex of both hemispheres. The exact position of surface and deep electrodes is shown in Fig. 1.

Six hours after surgical procedures, bipolar EEG recordings were obtained by means of a Galileo 8-channel EEG machine, model E 10b. After 30 min of control recording, 1,000,000 I.U./Kg Na-penicillin G dissolved in 4 ml of saline was slowly injected into the marginal vein of one ear. 4 control animals received saline only. Recordings were taken for up to 3 hours.

At the end of the experiments the animals were sacrificed by an overdose of i.v. pentobarbital. The brain was removed and the position of the deep electrodes was histologically verified. The recordings were examined visually by two of us. Attention was focused mainly on cortical spindling activity before and after penicillin injection, penicillin induced interictal spikes, the spindles-spikes temporal relationship. The cortical spindles were examined for frequency (number × min) and duration, both in the baseline conditions and 90 to 60 min after penicillin, during the highest spike activity.

The frequency of spindles was statistically evaluated by the Wilcoxon test. The duration of spindles was tested by analysis of the variance.

Results

Baseline EEG activity, recorded in all animals, showed the typical features already described by Monnier and Gangloff [10] and by Longo [7]. The spindles, appearing during quiet wakefulness, had a mean frequency of 8.8/min (± 2.1) and mean duration of 1.5 s (± 0.4).

Modifications of baseline activity were not observed in the 4 control animals injected with saline.

In 2 penicillin treated animals no important EEG changes were observed. 2 animals were not included in our study because they showed status epilepticus with focal seizures secondarily generalizing from the cortex or from the thalamus.

In the remaining 20 animals interictal spikes were evident 5-15 min after penicillin injection. They first appeared from the cortical or subcortical leads, particularly from the left cortex or from the IT and progressively increased in frequency and amplitude. The highest spike frequency (40/min) and amplitude (600 μV) were usually observed 30-90 min after penicillin. Spike activity gradually disappeared 90-180 min later.

Concerning the localization of interictal epileptic EEG activity, spikes or polypsikes were always present in the cortical leads. They occurred constantly associated to spindles, at the onset, during or sometimes at the end of the spindling complex, in a very randomized way. Rare spikes were noted

Fig. 1. Position of surface and deep electrodes: 1-right sensorimotor cortex, 2-left sensorimotor cortex, 3-cornu Ammonis dorsalis (CAD), 4-lateral thalamic nuclei, 5-medial thalamic nuclei.