Spinal Cord Convulsions in Developing Rats

Abstract. Tonic hind-limb convulsions were elicited by electrical stimulation of the spinal cord. The flexor-extensor pattern characteristic of adult animals was observed in rats as young as 1 day old.

The tonic-clonic seizure pattern of adult rats produced by electroshock stimulation of the brain (*1*) usually does not appear until the 21st day of age. Pylkkö and Woodbury (*2*) observed that tonic extension induced by strychnine appeared in rats between the 12th and 16th day after birth. As reported by Esplin (*3*), stimulation of the cervical spinal cord in adult spinal animals can duplicate all the hind-limb motor patterns seen during generalized seizure activity in intact animals. In my experiments, the method of spinal cord stimulation has been employed to study spinal cord convulsions in young rats.

The technique of spinal cord stimulation was that described by Esplin and Freston (*4*) with appropriate modifications. Rats 1, 4, 8, and 12 days old were employed. The animals were decapitated at the cervical region, and the stimulating electrode (cathode) was inserted 4 to 5 mm into the cord. The anode was attached to exposed tissue of the neck. Square-wave stimuli 1 msec in duration and of varying frequency were delivered by a Grass stimulator. Stimulus intensity was 30 volts; it was established that this voltage was sufficient to stimulate the entire cervical cord for all ages of rats studied.

Spinal cord stimulation of 10-second duration was applied 15 seconds after decapitation. The abrupt change from hind-limb flexion to extension was measured by an electronic timer. The duration of flexion is employed as a standard index of seizure intensity; the longer the duration of flexion the less severe is the convulsion (*4, 5*). It was determined that the duration of flexion was independent of time of application of the stimulus between 10 and 40 seconds after decapitation. The tonic convulsion resulting from spinal cord stimulation overrode the weak clonic movements which followed decapitation.

Duration of hind-limb flexion at various frequencies of stimulation for rats 1 to 12 days of age is shown in Fig. 1. After termination of flexion, hind-limb extension continued throughout the period of cord stimulation and for a variable period thereafter. The flexion-extension sequence was present at all frequencies employed, even in 1-day-old rats. At each frequency of stimulation, the duration of flexion generally decreased with age, which indicates an increase in intensity of convulsion as the animals matured.

Of especial interest is the U-shaped curve obtained with increasing frequency during the early stages of development. The U-shaped curve for duration of flexion as a function of frequency is most prominent in 1-day-old rats. It can be noted that in these animals the briefest flexion was produced with 50 pulses per second. In 4-day-old rats the briefest flexion was observed with 100 to 200 pulses per second; and in 8- and 12-day-old rats the briefest flexion was produced with about 200 pulses per second. This may suggest that high-frequency stimulation produces a block, most prominent in the newborn, of transmission or conduction processes in the spinal cord necessary for exhibition of hind-limb extension.

The present results show that tonic convulsions can be elicited by electrical stimulation of the cord in 1-day-old rats. The flexion-versus-frequency curve obtained in 12-day-old rats is similar to the response observed in adult rats (*6*), which indicates that the spinal cord convulsion pattern has developed by 12 days of age. Although the spinal cord of 8-day-old rats responds to electrical stimulation, it does not respond to strychnine (*2*). It may be concluded that the inability of intact rats to exhibit a flexor-extensor convulsion with brain stimulation before 21 days of age (*1*) is due to lack of maturation of the brain rather than of the spinal cord (*7*).

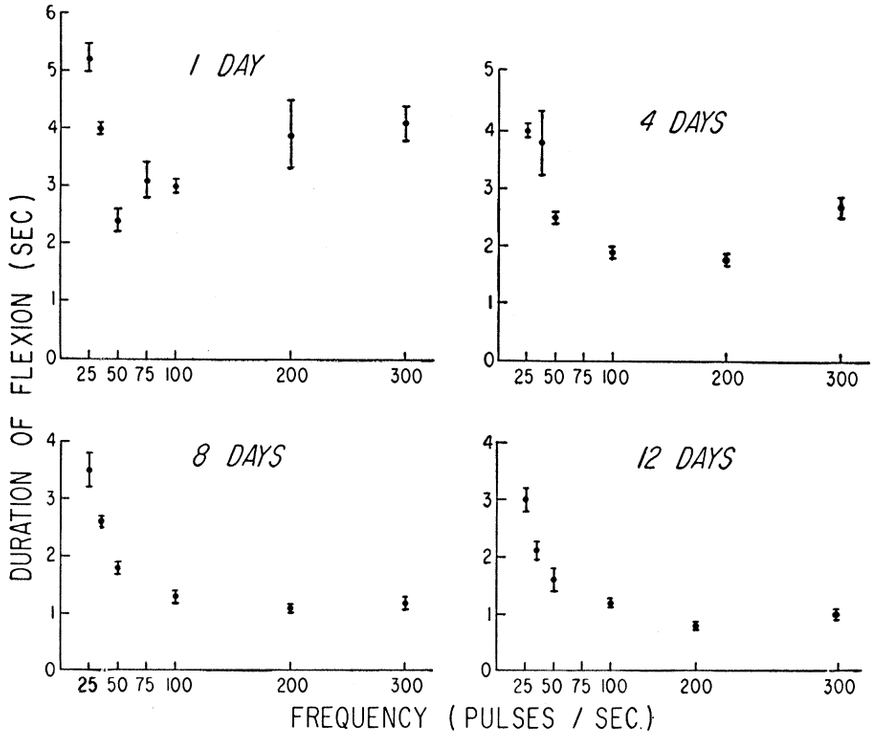

Fig. 1. Duration of hind-limb tonic flexion in young rats at various frequencies of spinal cord stimulation. Points with bracketed lines represent means and standard errors. Each mean is based on five to ten animals.

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References and Notes

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