In patients with paralysis of the respiratory muscles the lung ventilation has to be increased to much above the normal level. In the light of the facts now described the reason for this may be that, besides the pulmonary ventilation, their alveolar ventilation is also reduced.

Comparatively recently an attempt has been made to overcome dyspnea by blocking the phrenic nerves with lignocaine [2]. Such attempts can hardly be justified, for the paralysis of the diaphragm itself, as has been shown above, can lead to pulmonary insufficiency.

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EXPERIMENTAL PAIN AND ITCH SYNDROMES OF THALAMIC ORIGIN

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Syndromes of pain and itch of thalamic origin were produced in experiments on rats by inducing generators of pathologically increased excitation in the nucleus gelatinosus of the thalamus by means of a local disturbance of inhibitory processes in that nucleus caused by injection of tetanus toxin. The toxin was injected into the nucleus in microvolumes by a stereotaxic method. The results of the investigations agree with the concept of generator mechanisms of neuropathological syndromes which the authors have developed on the basis of the theory of the role of determinant dispatch stations in the activity of the nervous system.

KEY WORDS: pain and itch; thalamus; tetanus toxin; disturbance of inhibition; excitation generator; determinant dispatch station.

During a local disturbance of inhibition it has been found that generators of pathologically enhanced excitation can be formed in complex relay systems [1-3]. These generators lie at the basis of hyperactive central structures which form an increased functional volley [4]. This latter determines the character of activity of the parts of the central nervous system to which it is directed and, consequently, the behavior of the whole system which it activates. Hyperactive functional structures of this type have been called by the writers [5-7] hyperactive determinant dispatch stations (DDS). Hyperactive DDS generators transform physiological systems into pathological and induce the appearance of corresponding neuropathological syndromes [4-11]. On creation of a hyperactive DDS generator in the posterior horns of the spinal cord pain and itch of spinal origin appeared [12], whereas the creation of a DDS generator in the caudal nucleus of the trigeminal nerve induced a trigeminal syndrome of pain and itch [13].

The investigation described below showed that thalamic pain and itch syndromes can be produced by creating hyperactive DDS generators in the thalamic nuclei.

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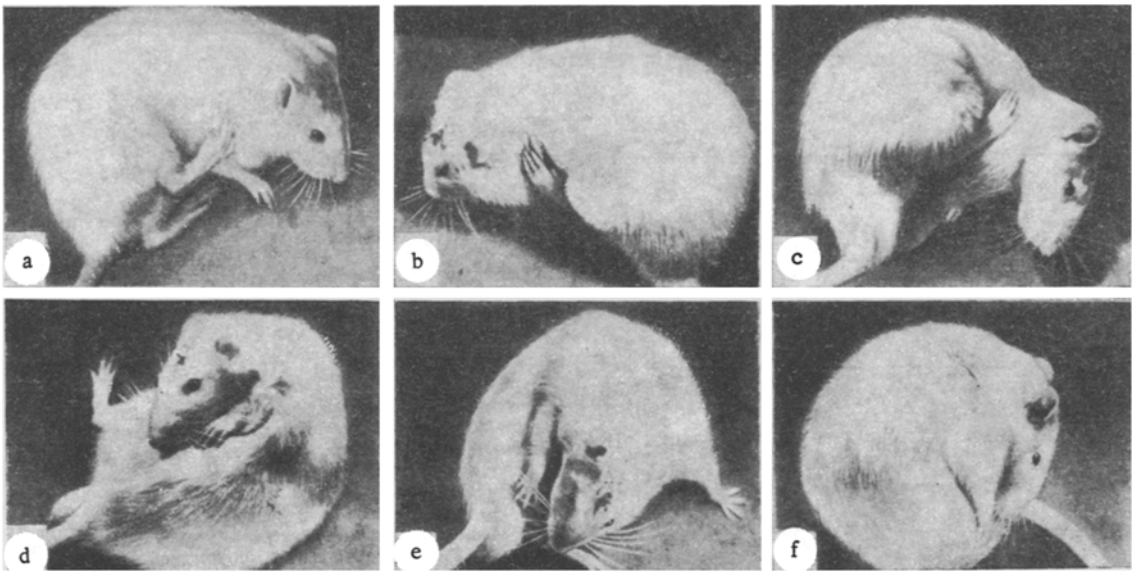

Fig. 1. Clinical picture of development of experimental pain and itch syndromes of thalamic origin: a,b) zones of scratching in region of right and left scapula; c,d,e,f) migration of zones of scratching.

EXPERIMENTAL METHOD

Experiments were carried out on 50 albino rats weighing 270-300 g. Tetanus toxin (TT) was used as the substance disturbing inhibition [14-19]. Purified, concentrated TT was injected into the animals under ether anesthesia from a microinjector by a stereotaxic method into the nucleus gelatinosus in accordance with the coordinates of Pellegrino's atlas [20] in a dose of 1-3 MLD for rats, in a volume of $1.5 \cdot 10^{-4}$ ml. Inactivated toxin was used in the control experiments, when none of the animals developed a pain syndrome.

EXPERIMENTAL RESULTS

From 2 to 2.5 h after injection of TT into the nucleus gelatinosus of the thalamus the rats began to move restlessly about the cage and to scratch an area of skin on the back in the region of the scapula sometimes with the right, sometimes the left hind limb. These scratching movements were rapid (Fig 1a,b). Sometimes the rats squeaked suddenly, jumped, and began to run around the cage; later they stopped, scratched the skin above the scapulae, and then began to run about again, and so on. In the course of time the bouts of scratching these areas of skin increased in frequency, duration, and intensity, the area of skin scratched became injured and ulcerated, and often the animals lacerated the tissues. These zones became trigger zones for facilitated provocation of the scratching bouts. However, these could appear spontaneously, without any special stimulation; with the course of time the frequency of the spontaneous bouts increased, the rats hurled themselves around the cage and sprang into the air. In the periods between bouts the animals assumed alert postures. After 4-6 h the attacks assumed clear features of pain and itch: loud cries, furious scratching, attempts to lick the scratched areas, shunning the places where the animals sat; meanwhile in many of the animals the zones of scratching and licking were seen to migrate. These zones appeared on the trunk and abdomen, in the region of the perineum and genitalia, on the legs and feet, and on the back (Fig. 1c,d,e,f). The bouts increased in frequency and severity and became paroxysmal in character. The animals became aggressive, hurled themselves against the walls, ran around the cage, bit furiously things that came their way, cried, and licked and chewed various parts persistently. During this period many stimuli (gentle tapping, light, blowing air on them, or touching them) induced scratching bouts. The rats died 24 h later. Autopsy revealed severe paralytic dilatation of the heart and hyperemia of the kidneys, liver, and, in particular, the lungs.

The facts described above indicate that after injection of TT into the nucleus gelatinosus of the thalamus the rats developed a severe pain syndrome, evidently accompanied by manifestations of itch. The pathogenetic mechanism of these syndromes can be considered to be the

same as that of the pain and itch syndromes of spinal [12] and trigeminal [13] origin described previously and obtained by the use of the same method of disturbance of inhibitory mechanisms and the formation of generators of pathologically enhanced excitation of neuron populations with disturbed inhibitory connections. The properties of the generators [1-3] explain many of the symptoms described and also the special features of pain syndromes of central origin found clinically in man (their paroxysmal character, varied duration of the attacks, trigger zones of facilitated provocation of the bouts, the "spontaneous" onset of the bouts, etc.). Pain syndromes of central origin are possibly based on the formation of excitation generators in the corresponding portion of the CNS concerned with pain sensation. In the clinical picture of the thalamic syndrome described above, besides the features of pain and itch, other phenomena showing evidence of involvement of the emotional sphere and higher nervous activity of the animals in the pathological process could also be observed.

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