MECHANISM OF THE PROTOPATHIC NATURE OF VISCERAL PAIN

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It was William Harvey [7] who first found that in a patient in whom healing of a chest wound left the heart partially exposed, neither touch nor pricking with a needle, nor pinching the heart caused the slightest sensation. At the beginning of the 20th century, when operations began to be performed under local anesthesia, it was shown that intact tissues of the abdominal organs likewise are insensitive to cutting, compression, or burning [9]. These facts are all the more interesting because, by contrast with somatic pain, which relatively rarely becomes pathological in character (causalgia, neuralgia), visceral pain is regularly distinguished by features of protopathic sensation. They are more diffuse than somatic pain, they have a marked affective character, and they are readily provoked by additional factors.

To elucidate the mechanisms of these features of visceral pain, the writers compared reflex responses of skeletal muscles to uniform local nociceptive stimulation of somatic tissues and tissues of the visceral organs.

EXPERIMENTAL METHOD

Experiments were carried out on 24 decerebrate cats and on 10 rabbits. Decerebration was performed at the intercollicular level by Sherrington's method. The experiment began 2 h after the operation as soon as the animal had recovered from ether anesthesia. In rabbits, the thorax and abdomen were opened under local anesthesia. Thoracic organs were studied during artificial respiration. A 0.1% solution of strychnine nitrate was injected in a dose of 0.2-0,5 ml into the rabbit's auricular vein. Nociceptive stimulation was applied by mechanical compression of the tissues with forceps or by burning with a thermocautery (diameter 0.3 cm).

EXPERIMENTAL RESULTS

Changes in postural tone of the cats clearly demonstrated differences in sensitivity of the tissues to nociceptive stimulation. Nociceptive stimulation of the skin of the foot as a rule evoked a flexor response. This was particularly marked if the joints were injured.

In full agreement with clinical observations, local nociceptive stimulation of the internal organs of the cats caused no changes in postural tone. Local burning of the heart (pericardium, epicardium, myocardium) and lungs (visceral pleura and paranchyma) by thermocautery evoked no changes in muscle tone. Local burning of the abdominal organs (liver, kidneys, spleen, pancreas, large and small intestine, mesentery, urinary bladder, ovaries) likewise caused no changes in decerebrate rigidity. A local burn of the testes was produced in males. As was stated above, a burn of the ovaries, located within the abdomen, caused no changes in decerebrate tone. By contrast, a burn of the testes evoked a sudden response of the hind limbs, which was manifested as a strong flexor reaction of the ipsilateral hind limb, sometimes followed by equally strong extensor jerks. The results of the experiments on rabbits were in full agreement with those obtained on decerebrate cats. The rabbits responded to acute local mechanical or thermal stimulation of the somatic tissues but gave no response to similar stimulation of the internal organs. The following observation was particularly interesting. In male rabbits, unlike cats, the testes are located in the inguinal canal and not in the scrotum. Nociceptive stimulation of the testes in rabbits, unlike that in cats, evoked no reflexes of the hind limbs.

These experiments showed that the internal organs have very few or no specific nociceptors. This can evidently be explained on the grounds that during evolution, unlike the

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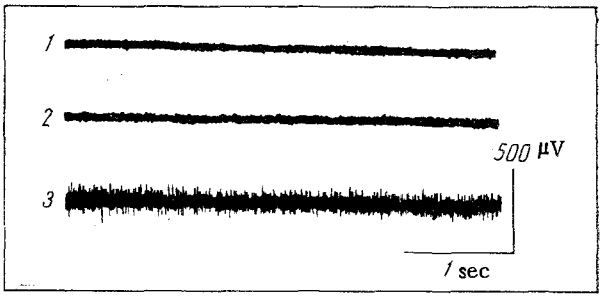

Fig. 1. Electromyogram of oblique abdominal muscles. 1) Background; 2) focal nociceptive stimulation of urinary bladder wall; 3) distension of urinary bladder.

external integument, they never came in contact with the external environment.

In opposion to the specific theory, according to which pain is caused by stimulation of specific nociceptors, a "summation" theory also has been suggested, and is based on the view that pain is caused by intensive receptor stimulation [8]. As many clinical and experimental observations have shown, in full agreement with this theory, visceral pain does in fact arise during an intensive flow of impulses from interoceptors: distension or spasm of the stomach and intestine, stretching of the mesentery, distension of the gall bladder or renal pelvis, an acute disturbance of the circulation arising during spasm or occlusion of the corresponding vessels, during inflammatory conditions leading to sensitization of receptors, and on direct stimulation of sympathetic nerves — cardiac branches, splanchnic nerves, involving many afferent fibers simultaneously, along which nociceptive impulsation spreads from the internal organs.

In this connection is is an interesting fact that visceromotor reflexes have been evoked by precisely these forms of stimulation of the internal organs [1, 3, 5, 6, 10]. This was confirmed by our own experiments also. For instance, local burning of the urinary bladder evoked no reflex changes of muscle tone, but stretching the bladder led to spasm of the abdominal muscles and flexion of the hind limbs (Fig. 1).

In full agreement with data in the literature was found that strychnine seizures are easily provoked in intact rabbits by tactile stimulation of the skin, but not by similar stimulation of the internal organs. Even the powerful nociceptive stimuli which we used did not provoke strychine seizures.

We know that strychnine seizures arise as a result of blockade of inhibitory synapses. Hence it is evident that since the internal organs are poorly supplied with specific nociceptors, they are also poorly supplied with inhibitory synapses. As our previous experiments showed, inhibitory synapses restrict responses to nociceptive stimulation of somatic tissues [4]. This suggests that the protophathic nature of visceral pain is determined by deficiency of inhibitory mechanisms, which normally restrict the sensation of pain. In the light of the above data, experiments which showed that somatic pain becomes protopathic in character when the inhibitory synapses of the dorsal horns of the spinal cord are blocked, are of particular interest [2].

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