ANALYSIS OF THE CAUSES OF INCREASED TREMOR IN THYROID HYPERFUNCTION

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The amplitude and frequency of the tremor of the hand and trunk, the tendon T- and H-reflexes, and inhibition of the latter on contraction of antagonist muscles were recorded in 33 children with diffuse toxic goiter and in 20 healthy subjects. In the patients the amplitude of the tremor was increased and its frequency reduced, the amplitude of the T- and H-reflexes was increased, and the intensity of reciprocal inhibition of reflex responses of the soleus muscle was reduced. Comparison of the amplitudes of the T- and H-reflexes before and during Jendrassik's maneuver showed that the increase in the T-reflexes was smaller and the increase in H-reflexes greater in the affected children than in the healthy controls. The increase in tremor during thyroid hyperfunction may arise, it is suggested, as a result of increased depolarization in the motoneuron pool, reduced efficiency of reciprocal inhibition, and weakening of suprasegmental influences spreading to the γ loop.

KEY WORDS: thyroid hyperfunction; tremor; segmental inhibition in disease; spinal cord.

Tremor associated with increased thyroid function can evidently be regarded as a form of physiological tremor aimed at the maintenance of posture.

One of the causes of the increased tremor may be a disturbance of function of individual components of the myotatic reflex, including the γ loop, the activity of which maintains the excitability of the α motoneurons at a certain level [6, 7].

In the investigation described below the technique of stimulation electromyography was used to compare indices for the state of certain components of the myotatic reflex in patients with thyroid hyperfunction and in healthy subjects.

EXPERIMENTAL METHOD

To assess the reflex activity of the α motoneurons, the H-reflex was recorded by Hoffman's method [10, 12]. To analyze the function of the γ-loop, parallel recordings were made of the tendon T- and H-reflexes. Since, unlike the H-reflex, the T-reflex requires the participation of muscle receptors, changes in the amplitude of the T-reflex accompanied by a constant level of the H-reflex are evidence of disturbed function of the γ loop [7, 12]. The role of suprasegmental cerebral structures in the regulation of function of both α and β motoneurons was investigated by means of Jendrassik's maneuver (voluntary contraction of the muscles of the upper limb), during which impulses travel mainly to γ motoneurons [11, 13, 14].

Twenty clinically healthy children and 33 patients with diffuse toxic goiter aged from 5 to 17 years were investigated. The diagnosis was based on enlargment of the thyroid gland, tachycardia, marked tremor of the limbs and trunk, weakness of individual muscle groups, an increased basal metabolism, and elevation of the protein-bound plasma iodine to 25-31 μg %.

The amplitude and frequency of the tremor were recorded in the standing position by means of a type

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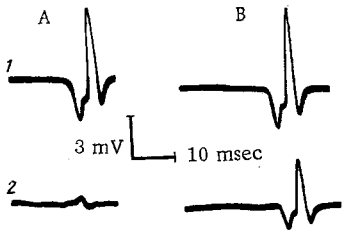

Fig. 1. Changes in H-reflexes of soleus muscle during contraction of antagonist muscles (dorsiflexion of ankle) in healthy subjects (A) and patients with diffuse toxic goiter (B): 1) initial amplitude of H-reflex; 2) amplitude of H-reflex during contraction of antagonist muscles.

SKG seismic detector fixed to the index finger or to the chest wall at the point where the 10th rib crosses the anterior axillary line. The T-reflex was investigated by means of a reflexometric device with electromagnetic hammer, triggered automatically by an ÉSU-1 stimulator. The H-reflex response was recorded from bipolar skin electrodes fixed above the active points of the soleus muscle. The tibial nerve was stimulated in the popliteal fossa by square pulses from 0.5 to 2 msec in duration. The control value of the T- and H-reflexes was 50-60% of the maximal. The indices were recorded photographically on a three-channel "Galileo" myograph. Jendrassik's maneuver was graded as follows: the subject gripped a dynamometer for 2-3 sec with an effort equal to 30% of maximal. The results of 5-6 tests were averaged for analysis. The rate of spread of excitation to distal parts of the motor fibers of the muscular nerves was determined by double stimulation at different points of the radial nerve trunk. The conduction velocities were calculated by the usual formula:

$$V = \frac{L}{\Delta t},$$

where L is the distance between the points of the nerve trunk and Δt the difference between the latent periods of the motor responses of the muscle (in msec). Statistical analysis of the data was carried out by Student's method or by means of the criterion of signs.

EXPERIMENTAL RESULTS AND DISCUSSION

Amplitude of the trunk tremor in the patients (679 ± 14 μV) was greater and its frequency (17 ± 0.1 Hz) less than in the healthy subjects (383 ± 15 μV and 180 ± 0.1 Hz, respectively; $P < 0.01$). Similar changes also were found when the tremor of the hand was recorded from the index finger.

The tremograms of the healthy and sick children were indistinguishable in the shape of their waves. No regular waves, which some workers regard as characteristic of the tremor in thyrotoxicosis [4], could be observed in the affected children.

Statistical analysis showed the existence of an inverse relationship in both the sick and healthy subjects between the amplitude and frequency of the tremor (coefficient of correlation minus 0.45, differences significant when $P < 0.001$). This suggests that the increase in the tremor in thyrotoxicosis arises as a result of a change in function of the regulatory systems responsible for the regulation of motor function under normal conditions.

The rate of spread of excitation along motor fibers of the muscular nerve was virtually the same in two groups of subjects (55 ± 0.5 m/sec in the patients, 54 ± 0.2 m/sec in the healthy subjects; $P > 0.05$).

The amplitude of the T-reflex (1815 ± 276 μV) and of the H-reflex (3061 ± 360 μV) was greater in the patients with diffuse toxic goiter than in the healthy children (759 ± 212 and 1863 ± 256 μV, respectively; $P < 0.02$). This could result from an increase in synchronizing influences on the motoneuron pool or an increase in the number of motoneurons in a state of subthreshold excitation.

It is well known that during depolarization the efficiency of hyperpolarization inhibition of motoneurons falls [3, 9]. To test whether the depolarization process in the motoneuron pool is in fact strengthened in patients with thyroid hyperfunction, inhibition of the H-reflex response of the soleus muscle was compared during dorsiflexion of the ankle. These investigations showed that in healthy children dorsiflexion of the ankle led to a decrease in the amplitude of the H-reflex, the degree of inhibition of which was 88 ± 3% of the control, but in the affected children inhibition was weaker – 68 ± 6% ($P < 0.05$) (Fig. 1). These results pointed to weakening of reciprocal inhibition in patients with hyperthyroidism, so that the hypothesis that the intensity of depolarization processes is increased in the motor units of the anterior horns of the spinal cord when the level of thyroid hormones in the body is raised is likely to be correct. Characteristically, in animals with toxicosis produced by thyroid administration the intensity of direct and reciprocal inhibition of extensor monosynaptic reflexes is reduced [5]; this also may be evidence of the onset of depolarization changes at the segmental level.

Investigation of descending influences on the function of the γ loop showed that the increase in the T-

reflex during Jendrassik's maneuver was smaller in the children with diffuse toxic goiter (44 ± 1%), but the increase in the H-reflex was greater (25 ± 1%) than in the healthy subjects (73 ± 4% and 10 ± 1%, respectively; $P < 0.05$). The intensity of descending facilitatory influences on the γ loop is evidently much reduced in patients with thyroid hyperfunction.

It is difficult to suggest that the greater increase in the H-reflex in the patients was attributable to increased facilitatory influences on the segmental apparatus and, in particular, on α motoneurons, for experiments on animals have shown that the effectiveness of these influences is reduced [1]. The writers are of the opinion that weakening of supraspinal influences in the presence of an excess of thyroid hormones is more than compensated by the increase in the "subthreshold fringe" of the motoneurons involved in the reflex response.

These investigations suggest that the increased tremor in thyroid hyperfunction may be the result of depolarization changes increasing the excitability of the α motoneuron, a decrease in the effectiveness of reciprocal inhibition, and a disturbance of the realization of suprasegmental facilitatory influences on the γ loop. The problem of whether the function of the muscle receptors is altered in hyperthyroidism is one that requires special investigation.

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