THE ELECTROMYOGRAM IN VOLUNTARY CONTRACTION OF THE MUSCLES IN OLD AGE

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Translated from Byulleten' Eksperimental'noi Biologii i Meditsiny,
Original article submitted September 13, 1960

Electromyography is widely used to study muscular activity and its pathological variations. However, among the large number of investigations on this subject, practically none deal with the electrical activity of muscles in very old people. Nevertheless, in old age all tissues undergo profound changes, and therefore a study of the electromyogram in this condition is of great interest. The present investigation is a study of features of the electromyogram shown by old people.

METHOD

We studied the electromyograms in 50 subjects aged 70 to 90 years produced by voluntary actions of the agonist and antagonist muscles of the arm and leg. As a control, we recorded electromyograms from 15 subjects aged 25-35 years.

The traces were obtained by applying silver electrodes and connecting them through an A. C. amplifier (which was free from distortion over a frequency range of 0.5-1500 cycles) to two channels of a MPO-2 oscillograph. Simultaneous recordings were made from a muscle and its antagonist, and a time marker giving 1/50 second intervals was recorded on the third channel.

After first training the subject to respond to a verbal signal, a movement was made producing a maximal contraction of one of the muscles investigated.

Each pair of muscles was activated in turn, so that the duration of contraction of the muscle was 1½ - 3 sec, as determined from the electromyogram.

RESULTS

In old people, after the signal had been given, voluntary contraction as a rule began later than it did in the control group, i.e., the latent period of the response was prolonged in most cases (see Table).

<table>
<thead>
<tr>
<th>Time between presentation of the signal and electrical response (in seconds)</th>
<th>Number of electromyograms</th>
<th>As percentage of the number of electromyograms</th>
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<tbody>
<tr>
<td></td>
<td>in group of people</td>
<td>in control group</td>
</tr>
<tr>
<td>0.1-0.5</td>
<td>95</td>
<td>39</td>
</tr>
<tr>
<td>0.6-0.9</td>
<td>68</td>
<td>18</td>
</tr>
<tr>
<td>1.0-2.6</td>
<td>75</td>
<td>3</td>
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</table>

In people over 70, judged by the increase of amplitude and frequency of the potentials, the contraction of the muscles was produced slowly and gradually to attain the maximum value of which the subject was capable. In 77 %
of the cases the maximal potentials occurred 0.6-3 sec after the onset of the contraction, but in the control group, in 67% of the subjects maximum contraction occurred after 0.1-0.5 sec (Fig. 1).

Thus in old age, the different neuromuscular units become active slowly and at different times. The effect may depend on a number of causes, including: the small number of cortical cells excited, a reduced excitability of the motoneurones of the spinal cord, and some failure of the muscle fibers themselves. We are inclined to accept the last of these causes, which we will discuss further below.

In the electromyograms of old people, another characteristic trait can be made out, and that is the short duration of the maximal contraction. The large-amplitude potentials characteristic of maximum tension continue in this group only for a short time, and their amplitude begins to fall before a signal to relax has been given. In 60% of the cases, in the aged group, the time for which the maximum amplitude was maintained was 0.4-0.9 sec, and in 40% it was 1-2 sec. In the control group, the maximal activity was maintained constant until the signal to relax was received (Fig. 2).

The electromyograms of old age also show a large number of small-amplitude potentials. Information on this point was obtained by measuring the potentials at the beginning of the contraction, at full contraction, and during relaxation. In the great majority of cases the potentials initially had an amplitude of 50-100 and 200-300 µV. In the leg muscles the amplitude was lower than in the arms. Next, the amplitude of the potentials increased to 400-500 µV. Among them there were a comparatively small number of potentials of 600-800 µV. Only in 2% of the 400 electromyograms taken are the potentials of 900-1200-1500 µV typical of the normal electromyogram present. We must note that the larger amplitude potentials were observed in patients in whom there was a general sense of well-being and in whom the muscles were more elastic and of an unaltered configuration and size.

In this way an analysis of the electromyograms showed that the majority of potentials in the old-age group were less than 400 µV in amplitude, even during maximal contraction, whereas in the control group under equivalent conditions most of the potentials lay between 900 and 1200 µV, and among them there were higher amplitude potentials of 1400-1600 µV.

The amplitude of the potentials is known to depend upon the synchronous contraction of different muscle fibers and on the number of motor units contracting simultaneously. The presence in the electromyograms of a large number