A STUDY OF THE ACTIVITY OF THE MUSCLES OF MASTICATION BY MYOGRAPHY AND MYOTONOGRAPHY

B. Kh. Kurlyand

From the Children's Hospital
(Chief Physician T. A. Sveshmikova), Town of Pushkin,
Scientific Directors – Professor E. K. Zhukov (Institute of Evolutionary
Physiology AN SSSR Leningrad) and Professor V. Yu. Kurylyandskii
(Moscow Medical Stomatological Institute)
(Presented by Active Member AMN SSSR, D. A. Biryukov)
Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 56, No. 7,
pp. 116-119, July, 1963
Original article submitted August 24, 1962

In previous reports [1, 2] we have described an apparatus – the tensomyograph, for recording myograms by a tensographic method, and we have also made an analysis of the results obtained during chewing. By comparison of the height of the muscle waves and the force exerted by the jaws it was found that the absolute strength exerted by the chewing muscles could not be deduced from these myograms. To record muscle tone (density of the muscle) we have constructed a special apparatus – the tensomyotonograph. We have given curves showing that a change of density gives a more accurate representation of muscle tone than does the myogram.

We have found no published description of an apparatus which enables muscle tone to be recorded. The object of the present investigation was to make calculations from the tonograms obtained and to compare them with the myogram thus obtaining a more accurate idea of the significance of these records for physiological investigation and for use in clinical practice.

Simultaneous recording of the myograms and of tone were made in 15 human subjects with normal masticatory apparatus. Altogether more than 300 curves were recorded.

Figure 1 shows curves obtained by making simultaneous records of a change in the width with myograms (A, C) and of the density of the tonograms (D, E) of the principal masticatory muscles. Curves A and B were recorded when the teeth were clenched three times in a position of central occlusion. The first two times there was a rapid compression (at a given signal) and relaxation; on the third occasion, after a rapid clenching of the jaws relaxation was slow.

Curves C and D were recorded on opening and closing the mouth without clenching the masticatory muscles. A comparison of these records shows that when the jaws are closed the peaks on the tonograph are higher than on the myograph. The explanation is that the myogram is not proportional to muscle tension, and therefore when the teeth are closed the height of the waves on the myogram show no further increase after a certain limit. The tonogram reflects more accurately the increase of muscle tone, which increases as muscle tension continues to increase and comes to exceed the myogram. On relaxation a reduction in height of the muscle fibre in the myogram occurs immediately after a certain reduction in the force of the pressure exerted by the jaws, while on the third tonogram reduction in the height of the muscle waves occurs immediately the force begins to be reduced. This effect is particularly noticeable during slow relaxation of the jaws.

During opening or closing of the mouth the changes of muscle tone were negligible, and the tonogram therefore showed peaks which are not very high. The higher peaks on myogram C are due to the fact that the myogram reflects not only changes in thickness of the muscle fibre but also movement of the muscle tissue related to movements of the lower jaw.

The curves we have considered offer an approach to a correct analysis of a record of chewing movements to be made. Figure 2 shows curves obtained by chewing hazel-nut kernels. The upper curves represent the myogram A and tonogram B of the base of the left masseter muscle when the subject chewed hazel-nuts on the left or working side.

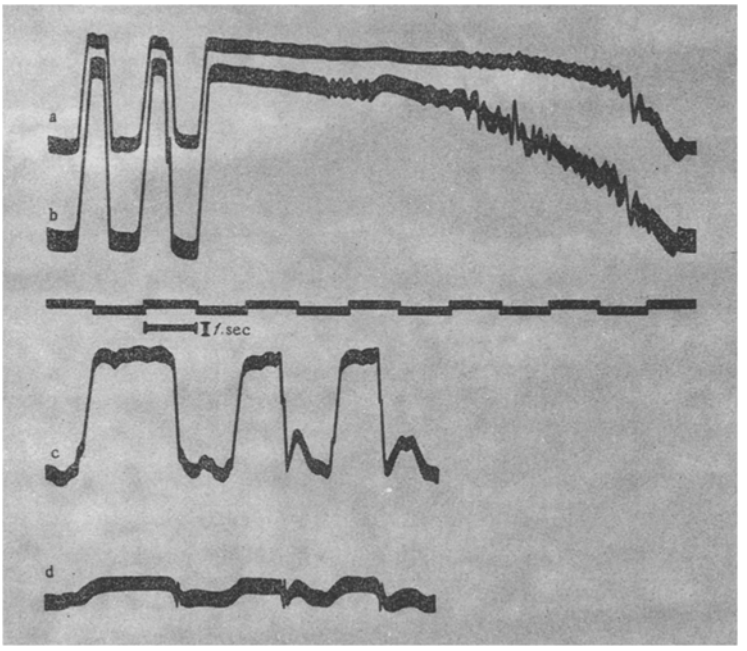

Fig. 1. Simultaneous recording of the changes in the thickness of (the myogram A, C) and density of (tonogram B, D) the muscle fibres of the masseter muscle. A, B) Teeth clenched; C, D) mouth opened.

The first phase represents the resting phase in curves A and B, and is represented by a straight line (1).

The second phase, when food is introduced into the mouth, shows on the myogram as a wave (A, 2) indicating a shift of the tissue of the muscle during a downward movement of the lower jaw. On the tonogram wave (B, 2) there is some indication that the tissue of the muscle has become denser on relaxation.

The third phase – the initial stage of chewing – shows on the myogram as an ascending portion (A, 3) indicating a movement of the lower jaw in the working direction. On the tonogram the wave (A, 3) is much smaller, indicating that the muscle fibres have been displaced without any change of density. At this time with the help of the lips and tongue, the nut has been brought to lie between the teeth. The mouth begins to close and the nut to break up. The myogram shows an ascending portion (A, 4) indicating a thickening of the fibres of the main portion of the masseter on contraction. At the same time the density increases (B, 4).

The fourth phase representing the principal act of chewing shows a regular alternation of chewing waves. Then each time the mouth opens and the lower jaw moves during the operative stroke there are ascending waves on the myogram (A, 6), and they are to be attributed to a displacement of the muscle fibres. The tonogram again confirms the density of the muscle fibres and shows very little alteration (B, 6). Closing the mouth is first recorded on the myogram by a descending wave (A, 7), because up till then, when this movement leads to the compression of the portion eaten, there is no thickening of the muscle fibre. However, when the mouth is closed, the food morsel is soon compressed.

The ascending wave (A, 8) on the myogram, indicates the onset of thickening of the muscle fibre as a result of tension. Simultaneously there is an increase in the density of the muscle (B, 10). The apex (A, 9) corresponds to the moment of maximum tension on the myogram, which is somewhat flattened, and on the tonogram it is represented by a sharp peak (B, 11). It is a characteristic effect that when the jaws relax after compressing the food the height of the peaks on the tonogram become smaller, while on the myogram this change is hardly noticeable. It is evident that as the food morsel becomes smaller the muscular force required to grind it is reduced. This effect scarcely shown up on the myogram because, as we have already pointed out, there is no correspondence between the force exerted by the muscle and the height of the peaks of the muscle wave.

The fifth phase (swallowing) shows a change in the rhythm of chewing movements, indicating the formation of a bolus. Typically this phase shows up mainly on the myogram and less on the tonogram (A and B, 12). The explanation is evidently that the movements of the lower jaw involve very small efforts.

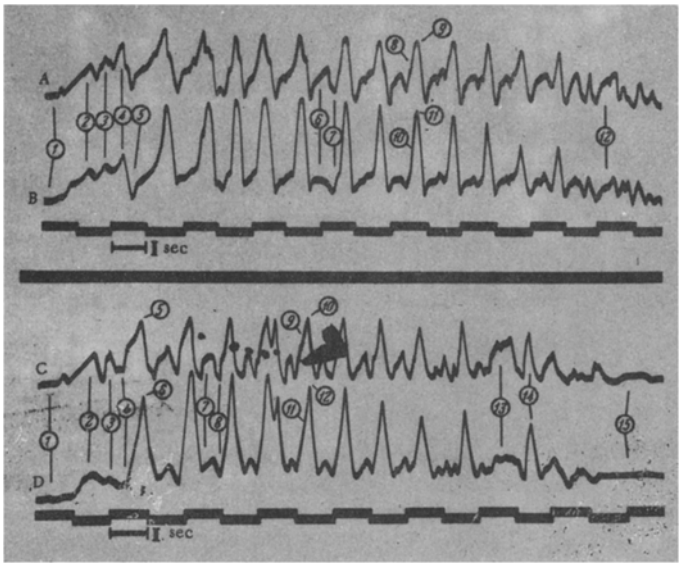

Fig. 2. Record of chewing hazel-nuts on working (left) side (AB), and on the balancing (right) wide (CD). A, C) Myogram of left masseter muscle; B, D) tonogram of left masseter muscle.

A comparison of the myogram and tonogram of the base of the masseter muscle on the working side show that there are important differences between the curves. The myogram reflects two factors; thickening of the muscle fibres during contraction and displacement of the muscle during the movement of the lower jaw. The tonogram indicates only changes in the density of the muscle during work; displacements scarcely show up on the tonogram at all. Therefore, unlike the myogram the tonogram shows up features related to opening the mouth and displacement of the lower jaw on the working side. On the other hand the height of the peaks on the tonogram is greater and indicates more accurately the force of muscular contraction. The peaks on the tonogram are sharp, and on the myogram are rather flattened. As the food morsel becomes smaller the height of the peaks on the tonogram becomes less, and on the myogram alters very little in height; the peaks become considerably longer, a result apparently of reduced muscular effort.

Let us now consider the characteristic features of the myogram and tonogram of the muscles of the opposite side. In Fig. 2 the upper curve C represents the myogram of the left masseter muscle, and the lower curve G is the tonogram of the same muscle while the hazel-nut was chewed on the right side.

The first or resting phase is represented by a straight line on curves C and D.

The second phase represents the introduction of food into the mouth, represented on the myogram by a small wave C, 2 associated with opening the mouth. On the tonogram the wave (D, 2) indicates an increased density of the muscle fibres as they relax.

The third phase representing the onset of chewing shows on the myogram as an ascending portion (C, 3) associated with opening the mouth. However, in the myogram the difference between the working and the opposite side is that in the latter knee of the curve is shallower and merges into the descending limb (C, 4), an effect which is to be attributed to displacement of the lower jaw towards the working side. On the tonogram, the corresponding section (D, 3) is shallow because the density of the muscle shows practically no change. Then the mouth begins to close and the nut is broken up. This effect is shown on the myogram and tonogram by peaks (C, 5 and D, 6) whose height indicates a considerable muscle tension.

The fourth phase, representing the main act of chewing, shows a considerable resemblance between the myogram and tonogram on the idle or balancing side. The explanation is that in the myogram of the balancing side features related to displacement of the lower jaw show up to a lesser extent. Opening the mouth and displacement towards the working side are on each occasion recorded as an ascending (C, 7) and a descending (C, 8) section while closure of the mouth related to breaking up the food fragments and requiring the expenditure of muscular effect is represented as an ascending portion (C, 9) and D, 11). The moment of maximum muscular tension is indicated by peaks (C, 10 and D, 12). These peaks of muscular effort on the myogram and tonogram of the balancing side are lower than on the working side.

The fifth stage is that of swallowing. It follows the period when the bolus is formed (C, and D, 13) and is indicated by a high peak (C, and D, 14), and represents the contraction of the masseters at the moment of swallowing. A period of rest then follows (C, and D, 15).

Thus on the balancing side the myogram and tonogram show a greater resemblance than on the working side. However, from the tonogram it would be difficult to determine on which side the chewing took place, whereas in the myogram the distinction can be made.

SUMMARY

The highly sensitive apparatus for recording myograms and tonograms of the muscles of mastication which we have described previously has been used to study the activity of these muscles in conjunction with strain gauges. From these experiments it is reasonable to conclude that a more profound analysis of masticatory activity can be made by simultaneous recording of tonograms and myograms. Tonography gives more precise information concerning muscular force, myography reveals features of articulation. It is advisable to use both methods simultaneously because they supplement each other.

LITERATURE CITED

1. B. Kh. Kurlyand, Abstracts of reports of IV Leningrad scientific conference of Stromatology (1961).
2. B. Kh. Kurlyand, Fiziol. SSSR, Vol. 49, No. 2 (1963).

All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
