oper. Photographs were taken of the tissue sections for comparison with the corresponding autoradiographs.

Sample autoradiographs show the distribution of the labelled material under normal conditions (Figure 1, a–d) and after acute complete ligation of the anterior descending coronary artery (Figure 2, a–d). In this, as in most cases, flow beyond the occlusion does not fall to zero. Within the area of reduced flow the indicator is distributed inhomogeneously. Reduction of flow is most marked in the inner layer of the left ventricular wall. This agrees with the findings of MOIR and DE BRA[4] and seems to indicate a primary nonhomogeneity of collateral supply.

Zusammenfassung. Es wird ein Verfahren zur autoradiographischen Darstellung der intramyocardialen Durchblutungsverteilung nach experimenteller Coronarocclusion angegeben. Im Versorgungsbereich akut verschlossener Coronararterien wird eine inhomogene Reduktion der Durchblutung beobachtet, wobei die Innenschichten regelmässig stärker als die subepicardialen Myocardanteile betroffen sind.

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[4] T. W. MOIR and D. W. DE BRA, Circulation Res. *21*, 65 (1967).

A Protective Mechanism for the Tongue: Suppression of Genioglossal Activity Induced by Stimulation of Trigeminal Proprioceptive Afferents

Biting on the tongue during mastication is a relatively rare incident in the healthy adult. The tongue, particularly its anterior portion, appears to be well protected by a very reliable mechanism. One could hypothesize that the masticatory activity itself plays a major role in the protection of the tongue by sending to the brain stem impulses which regulate the activity of certain portions of the tongue. It was the purpose of this study to verify this assumption. The genioglossus muscle offered itself as an ideal test organ since its activation leads to protrusion of the tongue beyond the occlusal zone of the teeth. Evidence will be presented here showing that the protrusive action of the tongue is inhibited by proprioceptive afferent activities from masticatory muscles. Portions of this work were previously presented in the form of an abstract[1].

Methods. 18 adult cats were used for this study. Surgery (tracheotomy; nerve dissections) was carried out under general anesthesia produced by short-acting sodium methohexital. Following all surgical procedures, a light anesthetic state was maintained by i.p. application of chloralose. Gallamine triethiodide was injected i.v. as a muscle relaxant. The method of proper ventilation of immobilized preparations was described earlier[2]. The body temperature was kept constant at 36–37 °C with radiant heat. Peripheral nerves were carefully dissected and suspended in a small pool of mineral oil. For recording and stimulating purposes, bipolar silver hook electrodes were applied to the proximal portion of the severed nerves. The following nerves were prepared: hypoglossal branches to the genioglossus muscle, lingual nerve, glossopharyngeal nerve branches to tongue mucosa, masseteric nerve, and the nerve to the anterior belly of the digastricus muscle. Reflexes to the genioglossus were elicited by electrical test stimuli (single pulse: 0.1 msec) to the ipsilateral lingual or glossopharyngeal nerve at the rate of 0.5/sec. Reflex depression was induced by applying conditioning stimulation (burst of 3 pulses; 500/sec; 0.3 msec; 3–5 V) to either the masseteric or the anterior digastric nerve. The conditioning interval is defined as the time elapsed between the beginning of the conditioning stimulus and the beginning of the test stimulus. The reflex potentials were amplified with a Tektronix RM 122 preamplifier and displayed on a Tektronix RM 565 oscilloscope. Averages of the polysynaptic reflex discharges were computed with the aid of a 'Computer of Average Transients' (CAT model 400A) and written out by an X–Y plotter. The area underlying the averaged reflex pattern served as an index of reflex activity. Areal measurements were carried out with the aid of a compensating polar planimeter.

Results. The effects of electrical stimulation of trigeminal proprioceptive afferents on reflexes to the protruder of the tongue (genioglossus) are illustrated in Figure 1. The computer-determined 'mean control' reflexes are shown in the upper part of the figure. If conditioning stimulation to the ipsilateral anterior digastric nerve (A, C) or the masseteric nerve (B) preceded the test stimulus by the optimal conditioning-test interval (15 msec; compare Figure 2), the reflex activity was considerably depressed ('conditioned responses'; lower part of Figure 1). Similar but slightly weaker effects were obtained when conditioning stimulation was applied to the contralateral masseteric nerve or anterior digastric nerve. Conditioning stimulation of the masseteric nerve also induced depression of reflexes elicited by glossopharyngeal input.

The relationship between the conditioning-test interval and the degree of reflex depression is demonstrated in Figure 2. The reflexes were elicited by test stimuli to the lingual nerve. Conditioning stimulation was applied to the ipsilateral anterior digastric nerve. The time course of reflex inhibitions shows an initial depressive effect at a conditioning interval of 5 msec. Maximal depression was observed at 12–15 msec. The total duration of the inhibitory phase ranged from 400–500 msec. Time courses with similar characteristics were obtained when conditioning stimulation was applied to the masseteric nerve, or when the genioglossal reflex was elicited by glossopharyngeal input.

Discussion. The preceding experimental observations have shown that electrical stimulation of the masseteric or anterior digastric nerve induces depression of reflexes to the genioglossus muscle. It is our contention that

[1] E. K. SAUERLAND and N. MIZUNO, Anat. Rec. *163*, 322 (1969).
[2] E. K. SAUERLAND, N. MIZUNO and R. M. HARPER, Expl Neurol. *27*, 476 (1970).

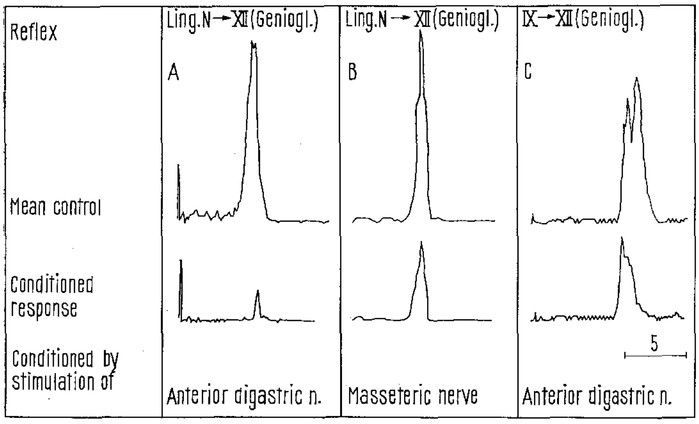

Fig. 1. Effect of electrical stimulation of trigeminal proprioceptive afferents on reflexes to the protruder of the tongue (genioglossus). Reflexes were elicited by single test stimuli to the lingual nerve (A, B) or the glossopharyngeal nerve (C), and recorded from the proximal portion of the severed hypoglossal branch to the ipsilateral genioglossus muscle. The computer-determined 'mean control' reflexes are shown in the upper part of the figure. If conditioning stimulation to ipsilateral trigeminal proprioceptive afferents in the anterior digastric nerve (A, C) or the masseteric nerve (B) preceded the test stimulus by the optimal conditioning-test interval of 15 msec, the reflexes were considerably depressed ('conditioned responses'; lower part of figure). Each tracing was computed from 50 individual responses. Time calibration: 5 msec.

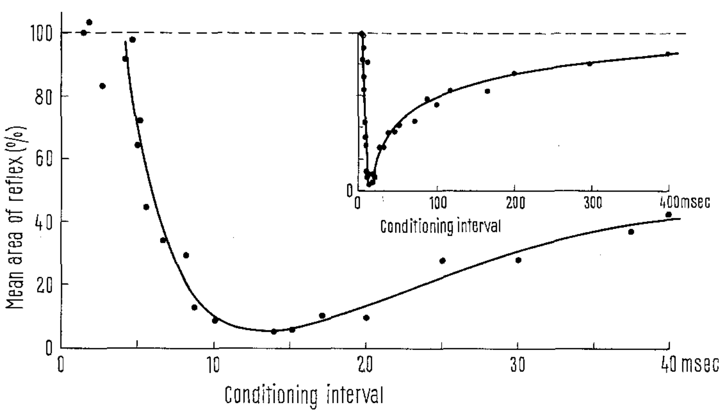

Fig. 2. Time course of reflex inhibition showing the effect of electrical stimulation of trigeminal proprioceptive afferents on reflexes to the genioglossus. Reflexes were elicited by single test stimuli to the lingual nerve and recorded from the hypoglossal branch to the ipsilateral genioglossus. Conditioning stimulation was applied to the ipsilateral anterior digastric nerve. Each point on the curve was computed from 50 individual responses. The smaller inset illustrates the remarkable duration of the inhibitory phase (400 msec or longer).

afferent activities in proprioceptive fibers are responsible for the observed inhibitory effect. This view is supported by the fact that natural stimulation of proprioceptors in the masseter or anterior digastric muscle produced identical effects as did electrical stimulation of the nerves of these muscles[3]. The remarkable duration of the time course of reflex depression suggest the involvement of a presynaptic inhibitory mechanism. There is experimental evidence that such a mechanism exerts its influence on the central endings of primary sensory neurons in cranial nerves. SAUERLAND and THIELE[3] demonstrated that activation of trigeminal proprioceptive afferents leads to presynaptic depolarization of lingual and glossopharyngeal nerve terminals.

Proprioceptors in the masseter (jaw closer) and anterior digastric muscle (jaw opener) are activated during mastication. Afferent activities from both muscles produce one and the same effect: a remarkable and long-lasting reduction of the reflex activity to the protruder of the tongue, i.e. a decrease in protrusive tongue action. This phenomenon constitutes a very effective protective mechanism for the antèrior portion of the tongue during masticatory activity. It appears that this protective mechanism already commences during the opening phase of the mouth[4].

Zusammenfassung. Die Reflexaktivität des Protrudors der Zunge (M. genioglossus) wurde durch die Aktivierung propriozeptischer afferenter Fasern im N. trigeminus bedeutend herabgesetzt. Polysynaptische Reflexe zum M. genioglossus wurden entweder durch Reizung des N. lingualis oder des N. glossopharyngicus ausgelöst. Bedingende elektrische Reizung der Nerven verschiedener Kaumuskeln induzierte eine bis zu 500 msec andauernde Hemmung dieser Reflexe.

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[3] E. K. SAUERLAND and H. THIELE, Expl Neurol. *28*, in press (1970).

[4] This research was supported by grants No. NS 06819-04 and No. MH 10083 from the United States Public Health Service. The authors are indebted to the UCLA Brain Research Institute for the use of the computer facilities. Dr. Mizuno's present address: Department of Anatomy, School of Dentistry, Hiroshima University, Hiroshima City, Japan.

Exercise, Blood Lactate and Food Intake

In man and other animals bouts of exercise are followed by a period of hypophagia which is succeeded by the restoration of energy balance within 1 to 2 days[1,2]. During exercize blood concentrations of lactate increase from a normal of 0.5–1.0 mM up to 15 mM[3], and we have shown that a 30-min i.v. injection of L-lactate (1.3–1.5 mmoles/kg) into monkeys, causing a maximum blood lactate concentration of 2.5 mM, decreased their food intake about 40% during subsequent feeding[4]. Since the lactate levels quickly returned to normal, the hypophagia appears to be a