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THE SILENT PERIOD IN THE EMG OF THE JAW MUSCLES DURING MASTICATION AND ITS RELATIONSHIP TO TOOTH CONTACT

by

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INTRODUCTION

Electromyographic studies of the jaw muscles have yielded valuable information on the physiology of the stomatognathic system. The degree and coordination of muscular contraction during movements and positions of the mandible are fairly well known. Recent polygraphic studies of the jaw muscles have also clarified the relationship between the electrical activity and the mechanical response (*Möller*, 1966; *Ahlgren*, 1967a; *Ahlgren & Öwall*, 1969). In one of these studies (*Ahlgren*, 1967a) it was shown that a silent period appeared within the EMG pattern during chewing and biting, and that this silent period coincided with the initiation of the occlusal phase. The purpose of this study was to analyse further this silent period of the EMG of the jaw muscles during chewing and biting.

MATERIAL AND METHODS

One thousand EMG records of 50 subjects, aged 10 to 20 years, were analysed. Polygraphic records (EMG and graphic recording of mandibular movements) of 10 of these subjects were also available for the analysis (*Ahlgren*, 1967a). One hundred EMG patterns were randomly selected for statistical analysis

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of the duration of the silent period. The measurements on the EMG were made to the nearest 0.25 mm., corresponding to 4 msec. The EMG records were obtained by intercutaneous wire electrodes in standardized positions on the temporal and masseter muscles (*Ahlgren*, 1967b). A Mingograph (frequency range 1—1000 cps) recorded both direct and integrated EMG. The sensitivity of the Mingograph was set at 300 μV/5 mm. The paper travelled at a speed of 60—100 mm. per second. Chewing and biting movements were performed at various rates. Chewing-gum and peanuts were used as test foods.

RESULTS

EMG pattern during chewing

In nearly all chewing movements recorded a short silent period appeared within the EMG pattern (Fig. 1). The duration of the period was 17.8 msec.

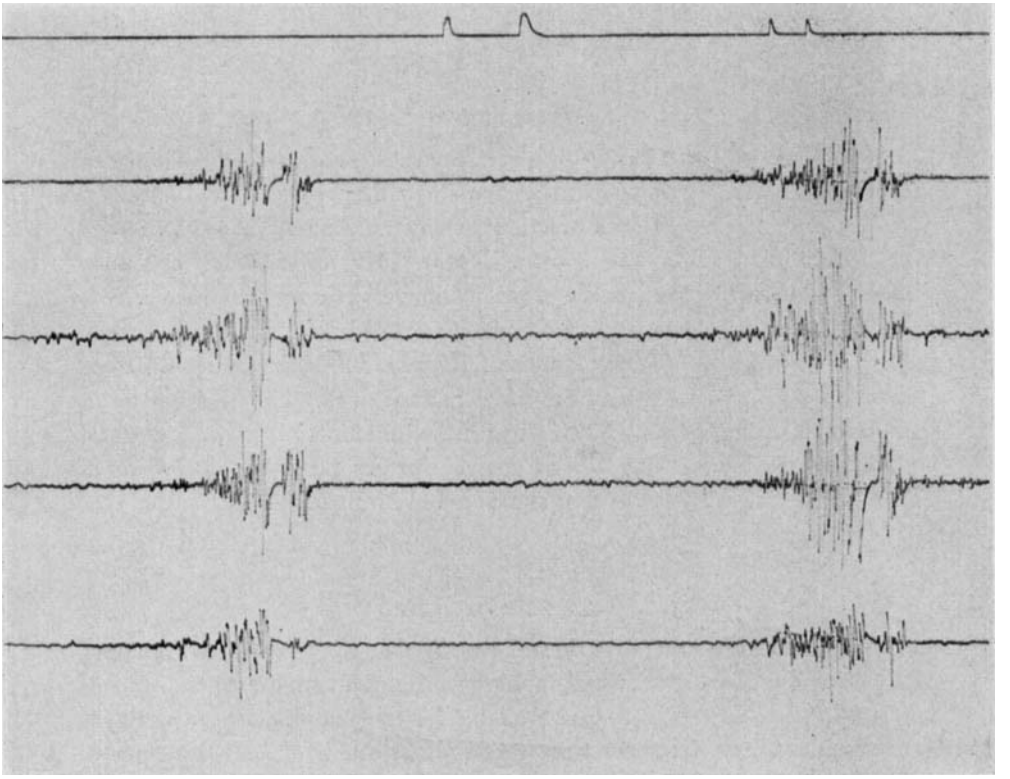

Fig. 1. The silent periods in the EMG of the temporal and masseter muscles during mastication. Paper speed 100 mm./sec.

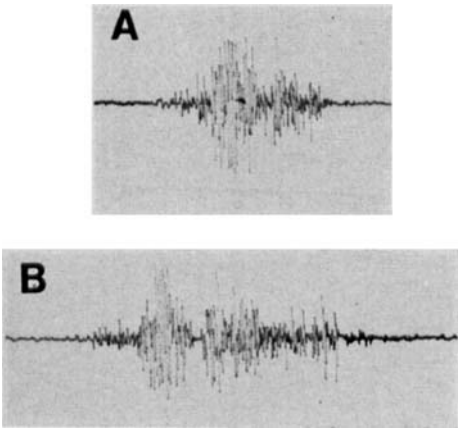

Fig. 2. EMG of the temporal muscle during gum chewing at different rates. A. Chewing rate 72/min. B. Chewing rate 35/min., showing late and early appearance of the silent period. Paper speed 60 mm./sec.

($\bar{x} \pm e = 17.8 \pm 1.0$, S.D. = 8.0). At a normal chewing rate (76/min.) the decrease in electrical activity usually occurred in the middle or toward the end of the EMG pattern. However, when the chewing rate was lowered to 37 strokes per minute the silent period appeared earlier in the EMG pattern (Fig. 2). The manner of chewing could also be related to the appearance of the silent period (Fig. 3). During chewing of gum (grinding strokes) the silent period appeared later than during chewing of peanuts (chopping strokes). In the first cycles during peanut chewing more than one silent period was also recorded within the EMG (Fig. 4).

Peak integrated EMG occurred sometimes before, sometimes after, the silent period (Fig. 5). Analysis of the polygraphic records showed that the silent period coincided with the tooth contact position of the mandible.

With a low paper speed, e.g. 30 mm. per second, the silent period could not be detected in the EMG owing to the compression of the EMG pattern. However, at paper speeds above 60 mm. per second the silent period was clearly visible.

EMG pattern during biting

At a paper speed of 60 mm. per second a definite silent period was recognized within the EMG pattern during biting movements (Fig. 6). The duration

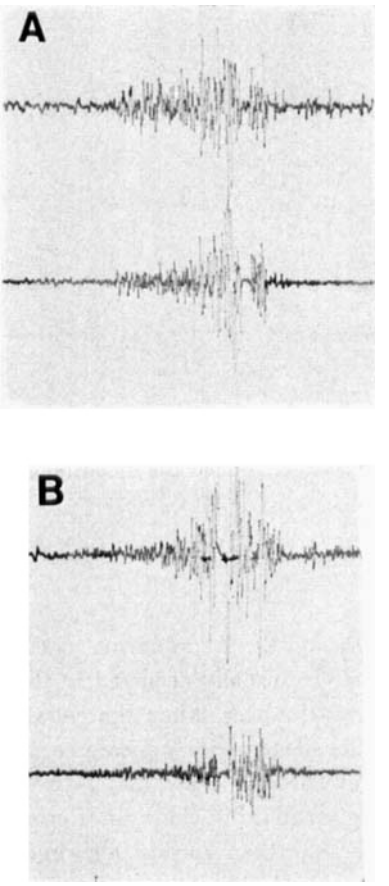

Fig. 3. The silent periods in the EMG from the temporal and masseter muscles during different manner of chewing. A. Grinding strokes. B. Chopping strokes. Paper speed 60 mm./sec.

of the period was 15.3 msec. ($\bar{x} \pm e = 15.3 \pm 0.5$, S.D. = 3.8). At a closing rate of 42 times per min. the silent period appeared in the beginning of the EMG pattern (Fig. 6). However, when the closing rate was increased the silent period occurred in the middle of the EMG pattern. In all biting movements recorded peak integrated EMG appeared after the silent period. The silent period always appeared at the initiation of the occlusal phase, e.g. with the mandible in intercuspal tooth contact position.

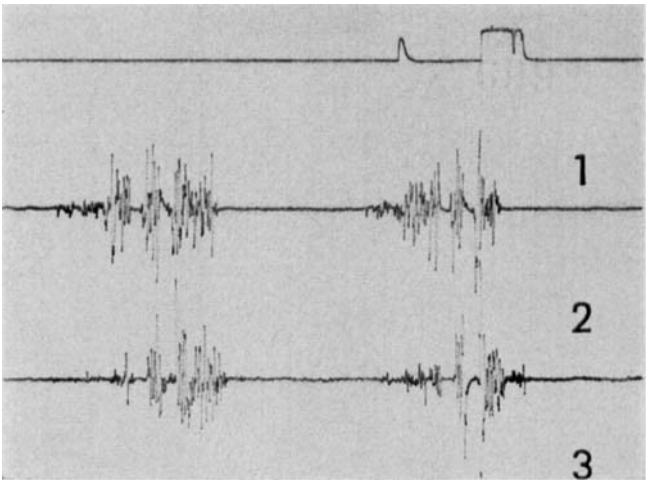

Fig. 4. The silent periods on the EMG from the temporal and masseter muscles during the first strokes of peanut chewing. Paper speed 60 mm./sec.

DISCUSSION

There are at least two physiologic mechanisms that can explain the appearance of a silent period in the EMG from the jaw closing muscles during mastication and biting. First, the decrease in electrical activity of the jaw closing muscles may result from the reciprocal inhibition associated with the jaw opening reflex. Pressure on the teeth and other oral structures has been found to elicit a jaw opening reflex (*Sherrington*, 1917; *Kawamura*, 1967). The duration of inhibitory state in the jaw closing muscles is around 10 msec. (*Hoffman & Tönnies*, 1948; *Kawamura*, 1958). The reflex is protective in nature (flexion reflex) but the importance of this reflex for cyclic jaw movements also has been discussed (*Kawamura & Fujimoto*, 1958; *Jerge*, 1964; *Kawamura*, 1967; *Ahlgren*, 1967a). The duration of the silent period found in this study, 18 msec., corresponds well with the duration of the inhibition following the jaw opening reflex. Another findings that also argues for the jaw opening reflex as a probable mechanism underlying the silent period in the EMG of mastication and biting is the close association between tooth contact and the silent period.

Another mechanism that also might explain the silent period in the EMG pattern during chewing and biting is inhibition from Golgi tendon organs during contraction of the jaw closing muscles, so-called autogenic inhibition. There are two types of muscle afferent fibers, muscle spindles and Golgi

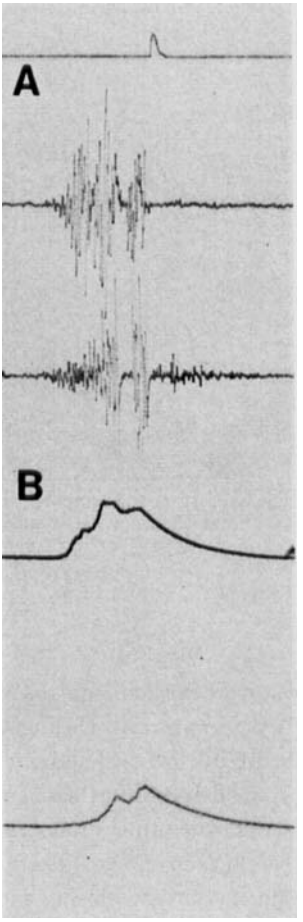

Fig. 5. Relationship between the silent period and peak integrated EMG from temporal and masseter muscles during chewing. A. Direct EMG. B. Integrated EMG. Paper speed 60 mm./sec.

tendon organs. During active contraction the muscle spindles are unloaded with a decrease — pause — in the rate of discharge, while the tendon organs are excited and show an increase in discharge rate. The tendon organs give rise to inhibition in synergist motoneurons and excitation of antagonist motoneurons (*Granit*, 1955). Thus, as the tension in the elevator muscles increases toward the end of the closing phase the tendon organ may be stimulated resulting in an inhibition — a silent period — of the jaw closing muscles. It is part of the same mechanism as that underlying the silent period

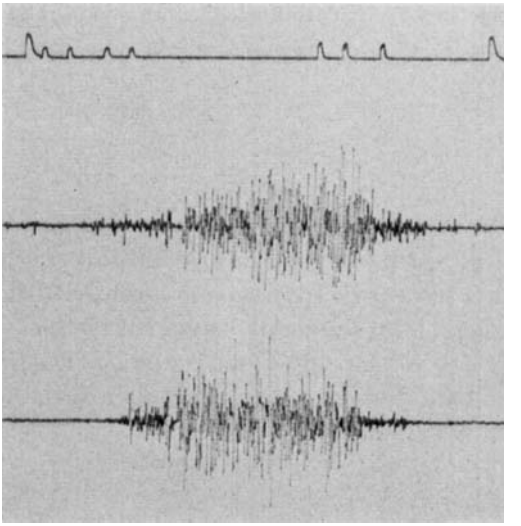

Fig. 6. EMG of the temporal and masseter muscles during biting movements showing the silent period in the early part of the EMG pattern. Paper speed 60 mm./sec.

in the EMG of the tendon jerk. The duration of the silent period following the myotatic reflex of the leg muscles is around 50—100 msec. (*Granit*, 1955; *Hufschmidt*, 1966). A similar duration — 100 msec. — has been found for the jaw muscles (*Ahlgren et al.*, 1966).

There are two factors that speak against autogenic inhibition being the mechanism behind the silent period in the EMG during chewing and biting. First, the prolonged duration of the inhibitory state found in autogenic inhibition. Second, the fact that the silent period usually appears before peak tension is developed in the jaw closing muscles (*Ahlgren & Öwall*, 1969) and the Goldi tendon organs discharge in proportion to the amount of tension developed. Thus, most evidence seems to indicate that the jaw opening reflex is the mechanism underlying the silent period in the EMG pattern during chewing and biting. The close relationship between tooth contact and the silent period makes it probable that the silent period works as a protective mechanism for the teeth, i.e., preventing chewing and biting forces from reaching damaging intensity.

Thus, the conclusions drawn from this study are that in chewing and biting movements a silent period appears within the EMG pattern of the temporal and masseter muscles at the initiation of the occlusal phase. The close association of the silent period with the make of tooth contact in intercuspal

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REFERENCES

Ahlgren, J., 1967a: Kinesiology of the mandible. An EMG study. Acta odont. scand., *25*:593.

—»— 1967b: An intercutaneous needle electrode for kinesiologic EMG studies. Acta odont. scand., *25*:15.

Ahlgren, J., Carlsöö, S. & Sonesson, B., 1966: The jaw jerk reflex. An EMG study. Unpublished material.

Ahlgren, J. & Öwall, B., 1969: Muscular activity and chewing force. A polygraphic study of masticatory movements. Arch. oral Biol. In print.

Granit, R., 1955: Receptors and sensory perception. Yale University Press, New Haven.

Hoffman, P & Tönnies, J. F., 1948: Nachweis des völlig konstaten Vorkommens des Zungen-Kieferreflexes. Plüg. Arch. f.d. ges. Physiol. *250*:103.

Hufschmidt, H. J., 1966: The demonstration of autogenetic inhibition and its significance in human voluntary movements. In Muscular afferents and motor control. Ed. *R. Granit*. Almquist & Wicksell, Stockholm.

Jerge, C. R., 1964: The neurologic mechanism underlying cyclic jaw movements. J. prosth. Dent., *14*:667.

Kawamura, Y., 1967: Neurophysiological background of occlusion. Periodontics, *5*:175.

Kawamura, Y. & Fujimoto, J. A., 1958: Study on the jaw opening reflex. Med. J. Osaka Univ., *9*:377.

Möller, E., 1966: The Chewing apparatus. Acta phys. scand., *69*: suppl. 280.

Sherrington, C. S., 1917: Reflexes elicitable in the cat from pinna, vibrissae and jaws. J. Physiol. (Lond.), *51*:404.

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