

## SHORT COMMUNICATIONS

# INHIBITORY EFFECTS IN THE MASTICATORY NEUROMUSCULATURE OF HUMAN SUBJECTS AT MEDIAN OCCLUSAL POSITION

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**Summary**—The reflex inhibitory responses evoked in masticatory muscles by contact of the dentition during the open–tap–close and open–close–clench jaw cycles were compared with the duration of inhibition at median occlusal position. Nine patients with normal occlusions were studied. Electromyographic recordings from the bilateral temporalis, masseter and anterior digastric muscles revealed a highly significant difference in the duration of the EMG silent periods elicited. Median occlusal position produced the longest inhibition of elevator muscle activity, and was considered the test parameter to evaluate the harmony of neuromuscular integration.

The role of the masticatory muscles in performing mandibular movements is documented, but coordination during function is limited to consideration of accurate interdigitation of the dentition at median occlusal position (Sicher and Du Brul, 1975). Jaw movements are described as beginning from and automatically terminating with precision into this position. Furthermore, in healthy individuals, median occlusal position is assumed to be that position of harmony between the teeth, muscles and joints, which is a prerequisite for maintaining the integrity of the entire masticatory system (Sicher, 1965).

During chewing and biting movements, the initiation of intercuspal tooth contact position results in a silent period (pause) within the electromyographic (EMG) activity pattern of the temporalis and masseter muscles (Ahlgren, 1969). This reflex inhibition of the elevator muscles is also reported following the open–close–clench (Griffin and Munro, 1969), and the open–tap–close jaw cycles (Hannam, Matthews and Yemm, 1969). However, the durations of the EMG silent periods evoked by these procedures vary considerably. In addition, patients with functional disturbances of the masticatory system have prolonged silent-period durations (Beemsterboer *et al.*, 1974), and sometimes the inhibitory responses are incomplete or absent (Griffin and Munro, 1971). Therefore, controlled quantitative comparisons should be made between the reflex EMG responses to tooth arch contact during these previously reported jaw closing cycles, and that which occurs at the physiologically significant median occlusal position. Nine control subjects with detectable occlusal interferences were considered to have normal occlusions as defined by Ramfjord and Ash (1971). Electromyographic recordings of the bilateral temporal, masseter and anterior digastric muscles were made with bipolar electrode placement as advocated by Ahlgren (1966). A poly-

graph unit (Grass instruments model 78, Quincy, Mass. U.S.A.) was used to amplify the EMG signals which were recorded on a magnetic tape recorder (Hewlett Packard Model 3955, Mt. View, Calif. U.S.A.). Recordings were made at 30 inches per second with replay at four times reduction of speed into the ink-writing oscillograph of the polygraph unit for visual monitoring and measurement of the duration of the EMG silent periods (accuracy 0.13 msec.). The sixth channel recorded jaw position with a Hall effect generator (American Aerospace Controls Inc., Farmingdale, New York, U.S.A.), which detected alterations in occlusal jaw position (McCall *et al.*, 1976). The control subjects were asked rhythmically to (1) open–tap–close, (2) forcefully open–close–clench, and (3) open rather wide and snap shut automatically to achieve median occlusal position, as described by Sicher (1965). Each procedure was repeated on seven consecutive occasions. The first and last cycle was disregarded, and the five other silent period durations were measured for each muscle examined.

Fig. 1 shows a typical oscillograph recording of the electromyographic activity of the right and left temporal and masseter and anterior digastric muscles. The reflex inhibitory effects of dentition contact on the temporal and masseter muscles were evident as the EMG silent period. No EMG pause was present for the anterior digastric depressor muscles. Using an analysis of variance programme (BMD. 08V Uni. of Michigan) for nested and fully crossed designs of equal cell sizes, the nine subjects showed a highly significant difference ( $F = 9.43$  and  $2$  and  $16$  d.f.  $p < 0.01$ ) between the three procedures (Table 1). Median occlusal position evoked the longest silent period durations (cell mean 14.78 msec) for the four elevator muscles. There was no significant variation ( $F < 1$ ) between the right and left sides, or between temporal and masseter muscles.

The procedural difference in the duration of the EMG silent period suggests that a standardized clinical method of producing this reflex inhibitory pause

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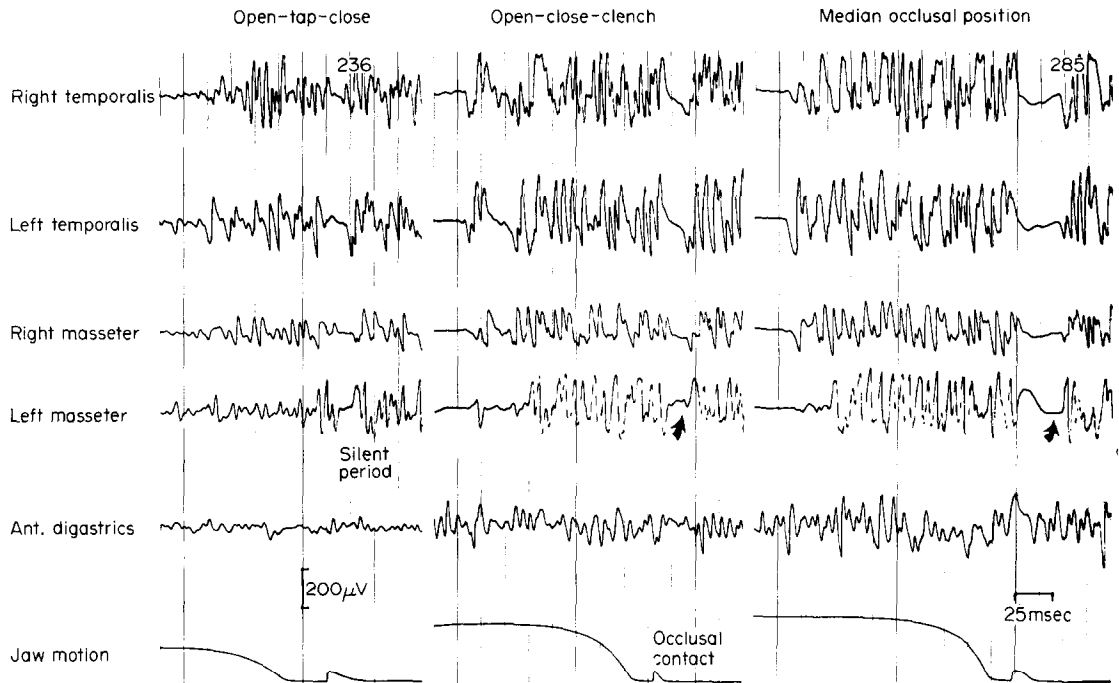


Fig. 1. Typical electromyographic tracings for normal subjects during controlled occlusal contact.

should be chosen. Especially when the EMG silent-period duration is used as a quantitative measure for patients with mandibular joint syndrome, where the psychophysiologic variables of lower muscle forces and lower pain thresholds may operate (Molin, 1973). The open-tap-close cycle was found an insufficient stimulus to consistently elicit silent periods, and another study reports a lack of inhibition following 20.7 per cent of occlusal taps (Brenman *et al.*, 1968). The duration of the EMG silent period found in the open-close-clench cycle (mean 13.6 msec) was similar to the results in 72 male and 72 female subjects (13 msec approximately) of the study by Griffin and Munro (1969). At median occlusal position, the mean silent-period duration of  $14.8 \pm 0.3$  msec more closely approximated the mean duration of  $15.3 \pm 0.5$  msec during biting movements (Ahlgren, 1969), which implies neuromuscular functional significance to this occlusal position.

The term EMG silent period should be reserved for reflex pauses in muscle activity following a stimulus of some sort (Shahani and Young, 1973). In particular, the silent-period duration in the masseter

muscles is associated with proprioceptive and sensory feedback from the stimulus strength and degree of muscle tension. Furthermore, a positive significant correlation is shown between the duration of masseter and temporalis muscle contraction and the duration of the inhibitory period (Munro and Griffin, 1970). Probably the reflex silent period is derived from a tension-servo responding to velocity changes in loading and unloading in muscles, together with the subjects somatic reaction to the load and/or position (Herman and Mayer, 1969). Therefore, the procedure which can develop the maximal jaw closing velocity and muscle force, namely median occlusal, is the method of choice to evoke masticatory EMG silent period durations for quantitative analyses.

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Table 1. Cell means and deviations (msec) of the EMG silent period durations for the normal subjects (S.E. of mean  $\pm 0.29$  msec).

Procedures	Open-tap-close	Open-clench-close	Median occlusal position
Muscles examined			
Right temporalis	10.91	13.83	14.62
Left temporalis	10.71	13.75	14.93
Right masseter	10.91	13.53	14.72
Left masseter	11.23	13.09	14.85

#### REFERENCES

- Ahlgren J. 1966. Mechanism of Mastication, Appendix. *Acta odont. scand.* **24**, Supplement 44, 87-105.
- Ahlgren J. 1969. The silent period of the EMG of the jaw muscles during mastication and its relationship to tooth contact. *Acta odont. scand.* **27**, 219-227.
- Beemsterboer P., McNamara D. C., Holden S., and Ash Jr. M. M. 1974. Effect of bite plane splint on EMG silent period duration. Internat. Assoc. for Dent. Res. Preprinted abstracts, 52nd General Meeting, Abstract 458.

- Brenman H. S., Black M. A., and Coslet G. J. 1968. Interrelationship between the electromyographic silent period and dental occlusion. *J. dent. Res.* **47**, 502.
- Griffin C. J. and Munro R. R. 1969. Electromyography of the jaw-closing muscles in the open-close-clench cycle in man. *Archs oral Biol.* **14**, 141-149.
- Griffin C. J. and Munro R. R. 1971. Electromyography of the masseter and anterior temporalis muscles in patients with temporomandibular dysfunction. *Archs oral Biol.* **16**, 929-949.
- Hannam A. G., Matthews B. and Yemm R. 1969. Changes in the activity of the masseter muscle following tooth contact in man. *Archs oral Biol.* **14**, 1401-1406.
- Herman R. and Mayer N. H. 1969. The silent period and control of isometric contraction of the triceps surae muscle. *Electromyography* **9**, 79-84.
- McCall Jr. W. D., Bailey J. O. and Ash Jr. M. M. 1976. A quantitative measure of TMJ dysfunction: Phase plane modelling. *J. clin. Periodont.* in press.
- Molin C. 1973. Studies in mandibular pain dysfunction syndrome. *Swedish dent. J.* Supplement 4, **66**, 1-55.
- Munro R. R. and Griffin C. J. 1970. Analysis of the electromyography of the masseter muscle and the anterior part of the temporalis muscle in the open-close-clench cycle in man. *Archs oral Biol.* **15**, 827-844.
- Ramfjord S. P. and Ash Jr. M. M. 1971. *Occlusion* 2nd Edn. Chap. 4, pp. 103-107. W. B. Saunders, Philadelphia.
- Shahani B. T. and Young R. R. 1973. Studies of the normal human silent period. In: *New Developments in Electromyography and Clinical Neurophysiology*, Vol. 3, 589-602, Karger, Basel.
- Sicher H. 1965. *Oral Anatomy*, 4th Edn. chap. 3, pp. 181-188. C. V. Mosby Company, Saint Louis.
- Sicher H. and Du Brul E. L. 1975. *Oral Anatomy*, 6th Edn. Chap 4, pp. 183-191, C. V. Mosby Company, Saint Louis.