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## MASTICATORY FUNCTION — A CINERADIO- GRAPHIC STUDY

### IV. DURATION OF THE MASTICATORY CYCLE

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#### INTRODUCTION

Relatively little information, of what effect different bite conditions have on the masticatory speed, is available in the literature. *Beyron* (1964) found among Australian aborigines chewing meat, an approximative duration of the chewing cycle of one second. Similar findings have been reported by *Shepherd* (1960) and *Woelfel et al.* (1962). *Woelfel et al.* found the duration of the masticatory cycle to be longer when unvulcanized rubber was used as test material than when peanut was chewed. *Ahlgren* (1966) studied the duration of the chewing cycle in children from 9 to 16 years of age. The boluses used were carrot and chewing gum. The mean duration was 0.77 sec for gum chewing and 0.58 sec for carrot. This difference in duration was almost significant. The difference in duration between the groups studied — normal and malocclusion — were not significant. *Bewersdorff* (1969) studied the chewing lapse of normal cases by an electrognathographic method. A difference in time between the chewing cycles could be observed when toffee and roast beef were used as test materials.

The present authors have studied the duration of the masticatory cycle by a cineradiographic method in persons with different bite conditions and with use of two testmaterials, toffee and bread.

## MATERIAL AND METHOD

The patient material consisted of three groups. (1) 11 persons with full upper and lower dentures, (2) 20 persons with full upper and partial lower dentures and (3) 14 persons with a full complement of natural teeth. The patient materials have been described in detail elsewhere (*Hedegård et al.*, 1967; *Lundberg et al.*, 1967 and *Wictorin et al.*, 1968).

The rate of the masticatory cycle was recorded by cineradiography. The apparatus consisting of a roentgen tube, an image intensifier and a 35 mm cinecamera, has been described elsewhere (*Lundberg*, 1963). The test foods consisted of soft wheat bread and a toffee, both containing 30 per cent barium sulphate. The bread was fairly easy to chew but the toffee was tough and hard. The analyses were performed using a lateral and a frontal projection (*Hedegård et al.*, 1967). The cinefilm was shown in a horizontal projector (*Lundberg*, 1963). The number of frames for a complete masticatory cycle was counted with the aid of an automatic counter on the projector. Ten consecutive masticatory cycles (3rd—13th) were counted and the average value was used in the analyses. The film speed in the camera was  $20.1 \pm 1.0$  frames per sec.

## RESULTS

The duration of the masticatory cycles in the different groups and with different test foods are shown in Table I.

No significant differences could be found between the three patient series. The standard deviations (Table I) demonstrated a fairly large variability among the patients. In spite of this variability significant differences on a 95 per cent level was found in cycle duration between the test foods in all groups (Table II).

In all patients there are two series of registrations, one in lateral projection and one in frontal projection. The variation in duration within each patient can be calculated by using the paired differences between those series in the formula  $s_e = \sqrt{\frac{\sum d^2}{2n}}$ , where  $d$  is the difference of the duration of an average cycle between two recordings in the same individual and  $n$  is the number of patients. The result of this calculation is shown in Table III.

By conventional analysis of variance the difference between the inter- and the intraindividual variance was tested. The F-values in Table IV show that significant differences exist for bread chewing in the full upper and partial lower denture serie as well as among those persons with a full complement

Table I

*The duration (sec) of the masticatory cycle in different patient groups and with different test food*

Patient group		Duration	
		Bread	Toffee
I: Full upper and lower denture	$\bar{x}$	0.79	1.04
	S.D.	0.15	0.25
	S.E.	0.04	0.06
II: Full upper and partial lower denture	$\bar{x}$	0.84	0.97
	S.D.	0.20	0.28
	S.E.	0.04	0.06
III: Individuals with full complement of teeth	$\bar{x}$	0.83	1.06
	S.D.	0.16	0.24
	S.E.	0.03	0.05

of teeth and for toffee chewing in both the denture series. The variance in duration of an average chewing cycle is therefore greater between different individuals than within an individual in these series.

## DISCUSSION

The cine-radiographic method here used to investigate the duration of the masticatory cycle is well suited for the purpose. Thus it is possible to make

Table II

*Difference (d) in duration (sec) of masticatory cycle with the two test materials, toffee and bread*

Patient group	$\bar{d}$	Sign. level
I: Full upper and lower denture	0.25	***
II: Full upper and partial lower denture	0.13	*
III: Individuals with full complement of teeth	0.23	***

Table III

*Intraindividual variation ( $s_e$ ) in duration (sec) of the masticatory cycle in different patient groups and with different test food*

Patient group	Bread	Toffee
I: Full upper and lower denture	0.10	0.10
II: Full upper and partial lower denture	0.11	0.12
III: Individuals with full complement of teeth	0.10	0.25

this investigation without, as in earlier studies (*Ahlgren*, 1966; *Bewersdorff*, 1969), use of reference objects attached to the front teeth of the lower jaw which may be suspected of causing disturbances in the normal masticatory pattern.

The values for the duration of the masticatory cycle given in this study show relatively good agreement with the values reported by other investigators (*Shepherd*, 1960; *Woelfel et al.*, 1962; *Beyron*, 1964; *Bewersdorff*, 1969). *Ahlgren*, however, found that the duration of the masticatory cycle was on an average 0.77 sec for the chewing of chewing gum and 0.58 sec for the chewing of carrots, which are considerably lower values. The difference, however, is probably to be explained in the light of differences in patient material (children) and the food chewed.

It was not possible to observe any significant differences in the chewing rate between the different patient-groups. Similar observations have been made by *Ahlgren* (1966) in studies of children with different types of bite. This would seem to indicate that the bite conditions do not influence the

Table IV

*F-test values of the interindividual and the intraindividual variance*

Patient group	Bread	Toffee
I: Full upper and lower denture	2.6	6.3**
II: Full upper and partial lower denture	3.33*	5.6**
III: Full complement of natural teeth	2.6*	1.04

chewing rate and that changes in these conditions would not affect the neuromuscular pattern in the direction of a change of the chewing rate. However, the interindividual variations are great, and to throw light on these problems it will be necessary to carry out intraindividual studies before and after a change in the bite conditions. However, despite the great interindividual variation it is clear that the consistency and other properties of the food used in the test do affect the chewing rate inasmuch as food that is difficult to chew reduces the chewing rate. Similar results have been reported by *Woelfel et al.* (1962), *Ahlgren* (1966) and *Bewersdorff* (1969) with other foods than those used here.

The values in Table III represent both the intraindividual variation and the error existing in the recording method. As this error is small as compared with the standard deviations obtained the main part of the variance is dependent upon the intraindividual variation. In all cases except one this is less than the interindividual variation, and it is significantly less in 4 of 6 cases. The nevertheless relatively great intraindividual variation might indicate that there exist no specific individual chewing patterns. If this is so, it is an important finding calling for further studies to try and ascertain the factors causing the great variances in an individual's chewing pattern.

#### SUMMARY

The average duration of the masticatory cycle in persons with different bite conditions and with use of two test boluses, toffee and bread, have been studied by a cineradiographic method.

The patient material consisted of three groups. 1. Persons with full upper and lower dentures, 2. persons with full upper and partial lower dentures and 3. persons with a full complement of teeth.

The duration of the masticatory cycle varied between 0.79 and 0.84 sec for bread chewing and between 0.97 and 1.06 sec for toffee chewing. No significant differences could be found between the three patient series. Significant differences on a 95 per cent level were found in cycle duration on between test foods in all groups.

The intraindividual variation was also tested and found to be considerable.

RÉSUMÉ

LA FONCTION MASTICATRICE — ETUDE CINÉRADIOGRAPHIQUE

IV. DURÉE DU CYCLE MASTICATOIRE

La durée moyenne du cycle masticatoire chez des personnes présentant différents types d'occlusion a été étudiée par une méthode cinéradiographique en utilisant deux types d'aliments pour les essais, caramel et pain.

Le matériel se composait de trois groupes de patients: 1. des sujets ayant une prothèse complète haut et bas; 2. des sujets ayant un complet du haut et un partiel du bas; et 3. des sujets ayant leur denture naturelle complète.

ZUSAMMENFASSUNG

KAUFUNKTION — EINE CINERADIOGRAPHISCHE UNTERSUCHUNG

IV. DIE DAUER DES KAUKYKLUS

Die durchschnittliche Dauer des Kauzyklus bei Personen mit verschiedenen Gebissverhältnissen ist untersucht worden. Dabei sind zwei Testspeisen, zähe Sahnebonbons und weiches Brot benutzt worden. Die Registrierung wurde mit röntgenkinematographischer Methode ausgeführt.

Die Patienten verteilten sich auf drei Gruppen; Gruppe 1. Personen mit totalen Oberkiefer und Unterkieferprothesen, Gruppe 2. Personen mit totalen Oberkiefer und partiellen Unterkieferprothesen, Gruppe 3. Voll bezahnte Personen.

Die Dauer des Kauzyklus variierte zwischen 0.79 und 0.84 Sek. für Brotkauen; 0.97 und 1.06 Sek. für zähes Toffeekauen.

An der Zyklusdauer zwischen den Testspeisen aller Gruppen konnte man signifikante Unterschiede an mindestens 95 % Konfidenzniveau feststellen.

Kein signifikanter Unterschied konnte zwischen den drei Patientserien beobachtet werden.

Auch die Variation unter den Individuen wurde untersucht. Man stellt diese als ziemlich gross fest.

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