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Reprint requests to:
DR. FRANCO MONGINI
CENTER FOR GNATHOLOGY AND PATHOPHYSIOLOGY
UNIVERSITY OF TURIN
SCHOOL OF DENTISTRY
CORSO POLONIA 14-10126 TORINO
ITALY

Influence of balanced occlusion and canine guidance on electromyographic activity of elevator muscles in complete denture wearers

Rodolfo Miralles, D.D.S.,* Ricardo Bull, M.D.,* Arturo Manns, D.D.S.,** and Enrique Roman, D.D.S.***

University of Chile, Faculty of Medicine and Faculty of Odontology, Santiago, Chile

Electromyographic recordings were made from the anterior temporal and masseter muscles during maximal voluntary clenching with complete dentures in the intercuspal position and in the laterotrusive jaw position with balanced occlusion and canine guidance. The different pattern of activity of the two muscles in the laterotrusive occlusal schemes studied suggests that their motoneuron pools receive different inputs. The lower activity in both muscles with canine guidance suggests that canine guidance may be a significant factor for preventing parafunctional activity in edentulous patients. (J PROSTHET DENT 1989;61:494-8.)

In asymptomatic subjects with a natural dentition, canine guidance, as opposed to group function, is associated with a greater reduction in electromyographic (EMG) activity of the elevator muscles on the laterotrusive or working side during maximal voluntary clenching.¹⁻³ The masseter muscle on the laterotrusive side also reveals a greater reduction in activity than does the anterior temporal muscle.

In complete denture treatment two theories concerning balanced occlusion have been proposed: (1) balanced occlusion in centric relation only,^{4,5} and (2) balanced occlusion in centric relation and lateral excursions.⁶⁻⁸ Proponents of the first theory (neurocentric) believe that it accommodates complete seating of the denture bases and centralizes forces on the residual alveolar ridges. They believe that patients function in a centric position exclusively. The second school of thought has used balanced occlusion in excursive movements as a means of enhancing the horizontal stability of the denture.

The influence of canine guidance compared with balanced

occlusion on the elevator muscular activity in laterotrusive excursions has not been studied in subjects wearing complete dentures. Laterotrusive position in subjects wearing complete dentures is a biasing factor, especially with canine guidance. Psychologic factors such as fear of pain, fracture, and/or instability of the denture may influence muscular activity. Nevertheless, it is important to determine whether the two laterotrusive occlusal schemes in subjects with complete dentures reduce elevator muscular activity with respect to intercuspal position as occurs in natural dentition. Therefore, we designed a study in which the effects of both types of occlusal guidances were assessed. In addition, we explored whether anterior temporal and masseter muscles are similarly influenced by both eccentric occlusal schemes.

MATERIAL AND METHODS

The study was carried out on nine denture-wearing subjects, one man and eight women, in the age range of 47 to 71 years (mean 58.7 years). They were selected according to a criterion of complete dentures with excellent retention, support, and stability and with balanced occlusion in laterotrusive position. None of the subjects showed evidence of dysfunction of the stomatognathic system. The subjects were tested when they were free from symptoms and approximately 3 months after the dentures were inserted.

Surface electrodes (Grass 5e 5s, Grass Instrument Co.,

*Assistant Professor, Department of Physiology and Biophysics, Faculty of Medicine.

**Associate Professor and Chief, Oral Physiology Laboratory, Department of Physiology and Biophysics, Faculty of Medicine.

***Professor and Head, Department of Prosthodontics, Faculty of Odontology.

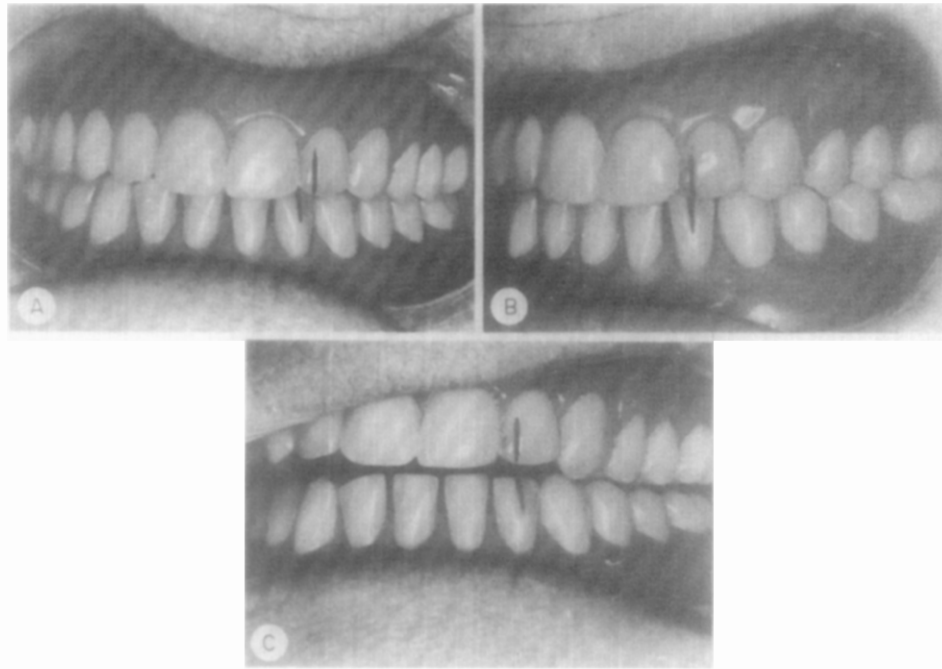


Fig. 1. Occlusal schemes studied in complete denture wearers. **A**, Intercuspal position; **B**, balanced occlusion; **C**, canine guidance.

Quincy, Mass.) were used for EMG recording. The electrodes were fixed on the left masseter muscle 1 cm above and below the motor point, on a line running parallel to the tragus of the ear across the motor point. One electrode was attached to the skin over the left anterior temporal muscle approximately 1 cm above the zygomatic arch and 1.5 cm behind the orbital border. The other electrode was placed 1.5 cm above the lower electrode.⁹⁻¹¹ A large surface ground electrode (approximately 9 cm²) was attached to the forehead. EMG activity was filtered (80 Hz to 100 kHz), amplified 1000 times, and then amplified again 10 to 50 times, integrated (time constant 1800 msec), and finally registered on a polygraph (Nihon Kohden RJD—4022, Nihon Kogyo Co., Ltd., Tokyo, Japan).

The subjects, sitting upright on a dental chair inside a Faraday cage, with the head supported and the Frankfort plane parallel to the floor, were submitted to three recordings of integrated electromyographic (IEMG) activity during maximal voluntary clenching in the intercuspal position and in the ipsilaterotrusive side with balanced occlusion and with canine guidance (Fig. 1). Canine guidance was obtained by adding composite resin (Super C, American Consolidated Mfg. Co., Philadelphia, Pa.) to the lingual surface of the left upper canine. Congruent markings were made on the maxillary and mandibular anterior teeth to consistently reproduce the same degree of lateral jaw position in both laterotrusive occlusal schemes.

The peak of IEMG activity during maximal clenching was recorded within a time period of 4 seconds and with a rest period of 20 seconds between clenching to avoid muscular fatigue.

The peak of IEMG activity was manually measured. Sub-

sequently, for each subject a mean value based on the three curves in each condition and for each muscle was used.

The mean value for each muscle in the intercuspal position was considered 100%. Mean values in the other conditions were referred to this one.

The paired comparison of IEMG activity between different conditions was performed through the Wilcoxon rank test.

RESULTS

Tables I and II show the mean values of IEMG activity for the anterior temporal and masseter muscles for each subject with the teeth in the intercuspal position and in the ipsilaterotrusive position with balanced occlusion and with canine guidance. Great variability was recorded in the temporal activity during maximal voluntary clenching of the teeth in the ipsilaterotrusive side with balanced occlusion. In some subjects activity increased with respect to intercuspal position whereas in others it decreased.

The median of IEMG activity with canine guidance in the anterior temporal muscle was lower than in the masseter muscle (39.52% and 60%, respectively).

Fig. 2 presents the group mean of IEMG activity for each condition. The activity of the anterior temporal muscle was similar in the intercuspal position and in ipsilaterotrusive balanced occlusion, and lower with canine guidance. The activity of the masseter muscle in the ipsilaterotrusive side with balanced occlusion and with canine guidance is lower than in the intercuspal position.

Table III shows the paired comparison of IEMG activity in the different conditions studied. For the anterior temporal muscle no difference was found between intercuspal po-

Table I. Integrated electromyographic activity of anterior temporal muscle in subjects wearing complete dentures in different conditions studied

Subject	Intercuspal position	Ipsilaterotrusive side			
		Balanced occlusion		Canine guidance	
		Mean	SD	Mean	SD
1	100	87.50	13.0	10.50	3.0
2	100	56.20	20.2	72.55	11.1
3	100	58.90	19.1	34.66	7.8
4	100	144.64	4.5	28.57	5.4
5	100	105.28	13.1	85.14	13.2
6	100	145.27	28.4	39.52	10.8
7	100	65.24	25.0	30.97	12.9
8	100	90.07	10.0	55.78	10.0
9	100	75.19	17.8	72.99	4.7

Mean values are expressed as percentage in relation to maximal clenching in intercuspal position.

Table II. Integrated electromyographic activity of masseter muscle in subjects wearing complete dentures in different conditions studied

Subjects	Intercuspal position	Ipsilaterotrusive side			
		Balanced occlusion		Canine guidance	
		Mean	SD	Mean	SD
1	100	63.33	8.3	50.00	2.1
2	100	48.00	8.0	60.00	14.0
3	100	91.57	6.3	63.16	6.3
4	100	39.02	2.8	46.34	14.6
5	100	44.37	11.0	26.84	5.2
6	100	63.48	19.1	51.30	1.7
7	100	101.55	9.9	94.92	5.6
8	100	83.57	9.4	63.92	3.1
9	100	83.36	22.0	62.20	12.8

Mean values are expressed as percentage in relation to maximal clenching in intercuspal position.

sition and balanced occlusion, whereas masseter muscle activity was significantly lower in balanced occlusion.

Activity with canine guidance was significantly lower than in intercuspal position for both muscles. In addition, muscular activity with canine guidance was significantly lower than in balanced occlusion for both muscles.

DISCUSSION

The higher group mean of IEMG activity in the intercuspal position in subjects with complete dentures in the present study, and with natural dentition,¹⁻³ agrees with Gibbs et al.¹² who pointed out that stability in the intercuspal position is of the utmost clinical significance and that the forces generated there are the highest and more enduring.

In this study, masseter muscular activity on the laterotrusive side with balanced occlusion was significantly lower than in the intercuspal position. This agrees with previous reports¹⁻³ in subjects with natural dentition in which masseter muscular activity with group function was significantly

lower than in intercuspal position. Anterior temporal muscle activity with balanced occlusion was similar to activity in intercuspal position. This finding is at variance with the reduction of EMG activity shown by Manns et al.¹ in the anterior temporal muscle with group function in relation to intercuspal position with the natural dentition. This might be the result of differences in the occlusal scheme used (balanced occlusion and group function) and differences between the function in subjects with complete dentures and natural dentition.

In this study, activity on the laterotrusive side with canine guidance was significantly lower than in the intercuspal position in both muscles. This agrees with previous reports showing that canine guidance, compared with group function, causes a greater reduction in EMG activity of elevator muscles in natural dentition.¹⁻³ However, EMG activity with canine guidance in this report differs from that in natural dentition, since in our study the anterior temporal muscle shows a greater reduction than masseter muscular activity,

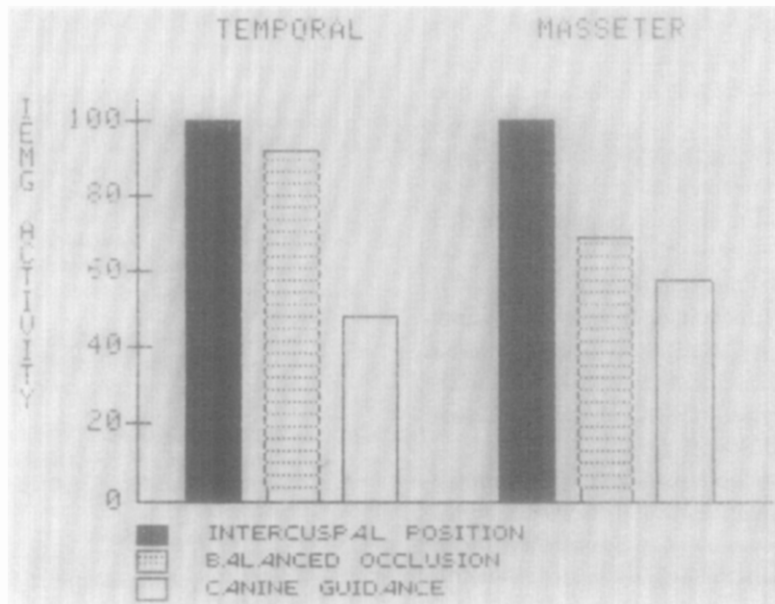


Fig. 2. Group mean of integrated electromyographic activity of anterior temporal and masseter muscles during maximal voluntary clenching with different occlusal schemes.

whereas in the natural dentition reduction is greater in the masseter muscle. This could be because canine guidance in the natural dentition, through periodontal mechanoreceptors, reflexly inhibits masseter motoneurons more than anterior temporal motoneurons.

In both laterotrusive occlusal schemes used in this study, the degree of lateral jaw position was kept constant, since it is known that the degree of lateral mandibular displacement influences the activity of the elevator muscles.^{13, 14}

The greater inhibition, and consequently lower muscular activity, during maximal voluntary clenching on the laterotrusive side with canine guidance than that found in intercuspal position could be the results of inhibitory feedback mechanisms on the mandibular elevator muscles. Since in the subjects studied periodontal mechanoreceptors are missing, mucosal, muscular, and temporomandibular joint receptors may be involved in these mechanisms. In this sense, displacement of the condylar position may change the feedback to the elevator muscles, as reported by Abe et al.¹⁵ The receptors in the temporomandibular joint can modify the stimulation threshold of motoneurons in masticatory muscles. The decrease in EMG activity with eccentric function, specially in the anterior temporal muscle observed with canine guidance in this study, may depend on changes in the input from temporomandibular joint receptors.¹⁶

It is important to consider that the eccentric functions studied during maximal voluntary clenching, especially with canine guidance, are a severe stressing factor. Psychologic influences, such as fear of pain, fracture, or instability of the dentures may have played some role in muscular activity reduction. To minimize these psychologic factors we encouraged subjects to clench as hard as they could. Such factors, however, should have affected activity of both muscles to a similar extent. Nevertheless, muscular activity of both mus-

Table III. Comparison of integrated EMG activity of anterior temporal (above diagonal) and masseter (below diagonal) muscles during maximal voluntary clenching in subjects wearing complete dentures (Wilcoxon rank test)

	Intercuspal position	Balanced occlusion	Canine guidance
Intercuspal position		NS	**
Balanced occlusion	**		**
Canine guidance	**	*	

p* < 0.05; *p* < 0.01; NS = nonsignificant.

cles differs in the two eccentric occlusal schemes studied, thus suggesting that their motoneuron pools receive different input.^{17, 18}

The different behavior of the two muscles with canine guidance in complete denture wearers in this study, with respect to natural dentition, could be due not only to the absence of periodontal receptors, but also to the presence of mucosal receptors involved in occlusal contact perception in subjects with complete dentures.^{19, 20} The input arising from these two receptor types may influence the motoneuron pools of both muscles to a different extent, thus explaining the different activity patterns observed.

The lower EMG activity of both muscles with canine guidance in complete denture wearers may be important for avoiding parafunctional activity in edentulous patients,^{21, 22} thus supporting the neurocentric theory.^{4, 5}

SUMMARY

Bipolar surface electrodes were used for anterior temporal and masseter EMG recordings during maximal voluntary clenching in nine subjects with complete dentures.

EMG activity in the intercuspal position and in the laterotrusive jaw position with balanced occlusion and canine guidance was compared three months after the dentures were inserted.

Group mean EMG activity in the masseter muscle with balanced occlusion was significantly lower than in the intercuspal position, whereas in the anterior temporal muscle it was similar. Group mean activity with canine guidance was lower than in the intercuspal position in both muscles. The median of EMG activity with canine guidance in the anterior temporal muscle was lower than in the masseter muscle.

The different pattern of activity of the two muscles in the laterotrusive occlusal schemes studied suggests that their motoneuron pools receive different input.

The lower EMG activity in both muscles in the laterotrusive position with canine guidance in subjects with complete dentures suggests that the lower activity may be a significant factor for preventing parafunctional activity in the edentulous patients.

We thank Dr. Fernando Lolas for reading and commenting on this article.

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Reprint requests to:

DR. RODOLFO MIRALLES
UNIVERSITY OF CHILE
FACULTY OF MEDICINE
DEPARTMENT OF PHYSIOLOGY AND BIOPHYSICS
CASILLA 70055
SANTIAGO 7
CHILE

Contributing author

Humberto Fuentes, D.D.S., Department of Prosthodontics, Faculty of Dentistry, University of Chile, Santiago, Chile.