

# Immediate Effect of Occlusal Errors on Masticatory Muscle Activity in Denture Wearers: A Pilot Study

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## ABSTRACT

Over the past three decades, little scientific progress has been made relative to occlusion in conventional complete dentures. Equal distribution of functional load throughout the residual denture foundation is likely an important factor in prosthesis stability and patient acceptance of dentures. A better understanding the relationship between denture occlusion and the physiologic behavior of muscles involved in mastication may prove beneficial in the clinical management of edentulism. The purpose of the present study was to determine the short-term immediate effects of unilateral and bilateral posterior occlusal interferences on masticatory muscle activity in edentulous patients treated with conventional complete dentures. Bilateral EMG activity of the anterior temporalis and masseter muscles was recorded in ten subjects at baseline, following introduction of unilateral posterior occlusal interferences, and following introduction of bilateral posterior interferences. During each experimental event, muscle activity was recorded bilaterally at maximal clench and the intended denture occlusion was electronically verified. Patients responded to questionnaires after each experimental intervention and following removal of occlusal interferences. Student's paired t-test was used to compare the data obtained ( $p = 0.05$ ). Results indicate no significant difference in EMG values at baseline, after introduction of bilateral posterior interferences, after the introduction of unilateral right posterior interferences and after removal of the occlusal interference. In the group with unilateral left posterior occlusal interferences there was a significant reduction in the EMG activity of the left masseter. Analysis of questionnaires did not reveal any significant findings. Taken together, results suggest that there was no significant difference in the EMG values of the patient after the introduction of the posterior interferences.

**Keywords:** EMG, Muscle, Complete denture, Occlusal interferences, Occlusal error.

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## INTRODUCTION

An occlusal interference is any tooth contact that inhibits the remaining occlusal surfaces from achieving stable and harmonious contacts.<sup>1</sup> It is suggested that occlusal interferences can increase masticatory muscle activity in dentate patients. This increase in muscle activity can lead to overload of the masticatory muscle, tenderness, pain and temporomandibular joint clicking.<sup>2-4</sup> Electromyographic (EMG) studies in dentate patients have shown that the

application of occlusal interference may increase the activity of several jaw elevator muscles at rest.<sup>5,6</sup> Although some studies have reported no change in muscle activity and few have also reported decrease in muscle activity upon the introduction of experiential occlusal interferences.<sup>7,8</sup> In addition, Ferrario et al studied the effect of the interference on muscle coordination and have found that experimental occlusal interference gave rise to asymmetric contractile activity in elevator muscles as well as have a potential to displace the mandible in a lateral direction.<sup>9</sup>

Occlusal errors/interferences are common occurrence in denture patients. The effects of occlusal interferences on masticatory muscle activity in denture patients are poorly documented in the literature. One study by Garrett et al studied the effect of improving the fit of poorly fitting dentures (through occlusal correction and changing the VDO) on the masticatory muscle activity. They concluded that patients needed to use less muscle effort while chewing and maintaining their initial masticatory performance following the occlusal corrections.<sup>10</sup> In another study by Perez et al they reported no change in muscle activity after improvement of occlusion and fit of old poorly fitting dentures. Thus, there are conflicting results in the literature.<sup>11</sup> Hence, this project was undertaken to study the effects of experimental unilateral and bilateral posterior interferences on the masticatory muscle activity of the elevator muscles in denture patients. As such, the objectives for this study are to study the immediate impact of experimental occlusal interferences on masticatory muscle activity of edentulous patients using EMG and also patient questionnaires.

## MATERIALS AND METHODS

This was a prospective, nonblinded, randomized, controlled clinical study. Patients were enrolled in the study, if they met the following inclusion criteria:

1. Patients had to be present for treatment and follow-up examination according to the scheduled requirements of the research project. Patients had to be in the age range of 18 to 75 years. Patients were selected regardless of sex, race or ethnicity.
2. Patients had to be free of any systemic disease or condition that would prohibit them from participating in the study.

3. Patients had to be free of residual roots, very deep undercuts, bony exostosis or any oral pathology in the oral cavity.
4. They had to be free of any temporomandibular joint, musculoskeletal or neurological disorders.

Once accepted into the study population, each patient signed a consent form designed specifically for this study and approved by the UTHSC, Institutional Review Board. Signed consent forms were securely kept on record in the Department of Prosthodontics at the UTHSC, College of Dentistry.

The study population consisted of ten subjects. They were randomly divided into two groups by an Excel random number generator program. Group A received unilateral right posterior interference and group B received unilateral left posterior interference. All the subjects were classified by the prosthodontic diagnostic index (PDI). Three of the subjects were class I (slightly compromised), two were class II, two were class III and the remaining three were class IV

(severely compromised). All subjects were between 45 and 75 years old. Seven subjects were female and three were male. Seven subjects were white and the remaining three were African-American. Each patient served as his or her own control to determine the effects of occlusion on muscle activity.

Complete dentures were fabricated with a balanced lingualized occlusal scheme and delivered to each patient. On the day of delivery any needed adjustments to the intaglio, cameo and occlusal surfaces of the complete denture were performed. A clinical remount was accomplished, and any existing interferences were removed. T-Scan (Tekscan, Inc, South Boston, MA) was used to verify that an accurate occlusal adjustment had been accomplished (Fig. 1). Once completed the activity of the masseter and the anterior temporalis muscles was recorded bilaterally using the BioPak EMG (Bio Research, Inc, Brown Deer, WI) to record masticatory muscle activity at baseline (Fig. 2).

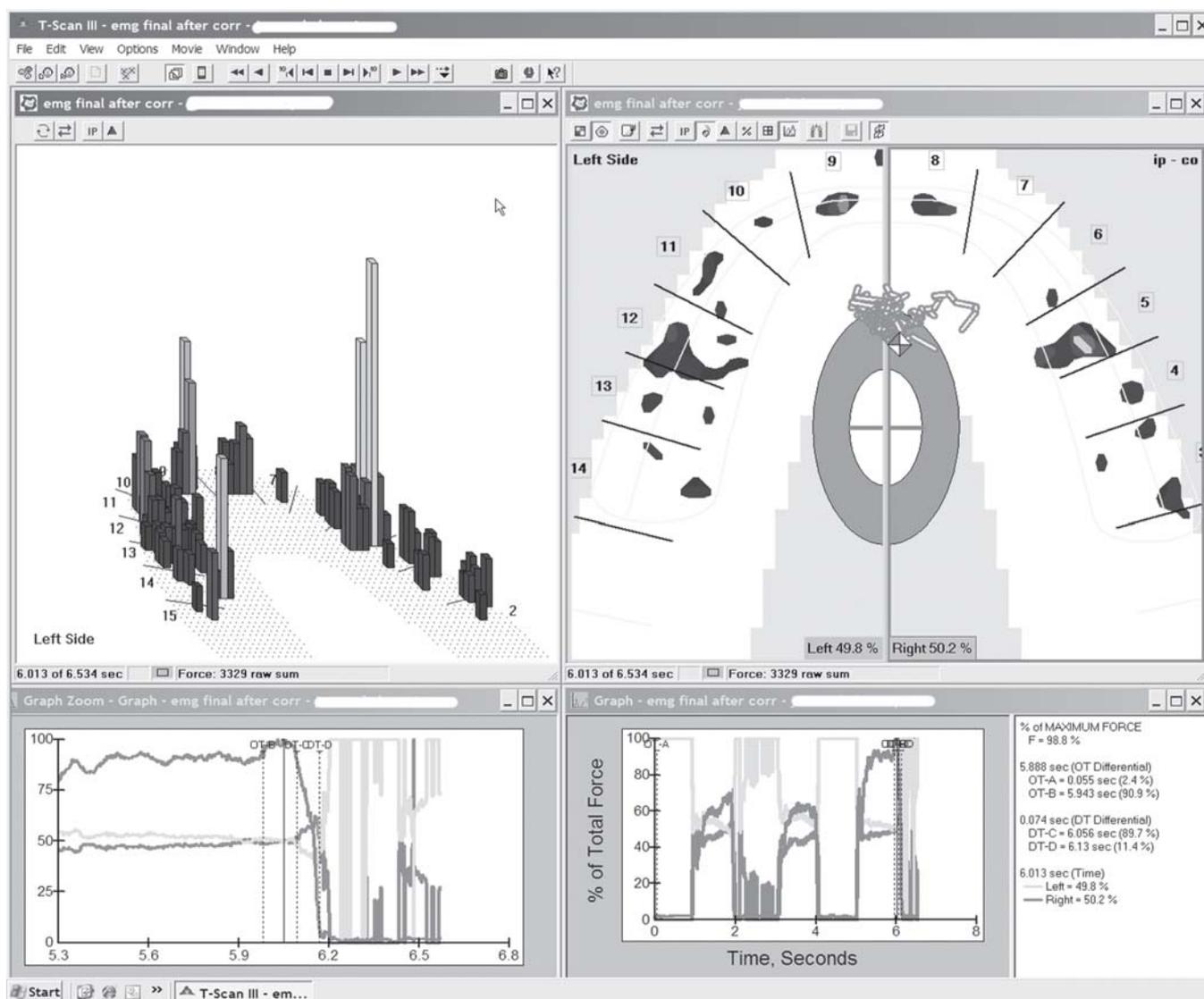


Fig. 1: Presentation of T-scan data on the computer screen

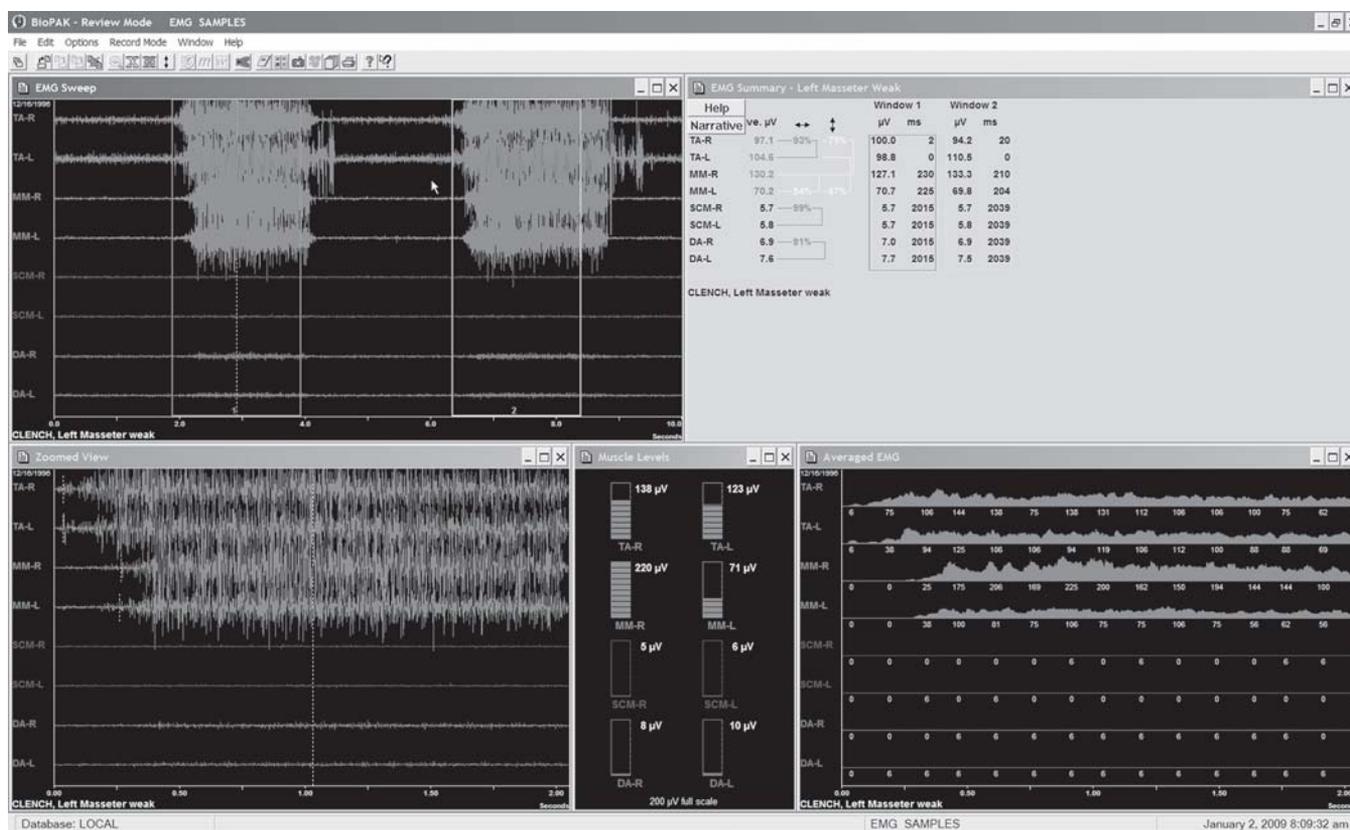


Fig. 2: Presentation of EMG data on the computer screen

All ten dentures were returned to the remount indices and composite resin was used to place bilateral artificial posterior interference on the occlusal surface of the most posterior teeth of quadrant III and quadrant IV of the mandibular complete denture (Fig. 3). This resulted in an opening of the articulator by 2 mm at the level of incisal guide pin.

Patients were given 30 minutes to adapt to the interference and then T-Scan was used to record the presence of the interference and verify the position and timing of the artificially placed interferences. Bilateral contact of the interferences occurred simultaneously and with the same

degree of force. Using a questionnaire (Appendix A) specially formulated for this project, patients reported their level of perception of the inaccuracy of the bite and then an EMG recording was made.

Five complete dentures were randomly selected and returned to the remount indices. Bilateral interferences were removed and composite resin was used to place an artificial posterior interference on the occlusal surface of the most posterior tooth of quadrant IV of the mandibular complete denture (Fig. 4). This resulted in an opening of the articulator by 2 mm at the level of the incisal guide pin.



Fig. 3: Complete denture with bilateral interferences



Fig. 4: Complete denture with right unilateral interferences

Patients were given 30 minutes to adapt to the interference and T-Scan was used to verify the position and timing of the artificially placed interferences. Using a questionnaire (Appendix A) specially formulated for this project, patients reported their level of perception of the inaccuracy of their bite and then an EMG recording was made. Exactly the same procedures were carried out on the remaining five subjects, except that they had the unilateral left interference.

Finally, all complete dentures were returned to the remount indices where artificial occlusal interferences were removed to once more reach an 'accurate occlusion'. This 'accurate occlusion' was verified by T-Scan. Once verified, EMG signal levels of the masticatory muscles bilaterally were recorded. Patients were asked to fill out a questionnaire (Appendix B) and were released from the clinic. During each EMG recording, each subject was seated comfortably and relaxed in a dental chair. The patients were asked to fix on a target on the wall, 90 cm away, to avoid lateral movements of the head. They were then asked to clench maximally. EMG for this task was recorded for the anterior temporalis and masseter muscles (bilaterally) by placing self-adhesive, disposable, silverchloride, bipolar electrodes over the greatest bulge of anterior portion of each muscle while the subject was asked to clench maximally. To reduce electrode impedance, the skin was cleansed with 91% isopropyl alcohol that was allowed to evaporate before placing the electrodes. The electrodes used were Bioflex (Bio Research, Inc, Brown Deer, WI) and were not removed in between the recordings thus, maintaining the same positions of the electrodes during all recordings. For each recording, every single patient was asked to clench their teeth maximally and EMG measurements were recorded. Significance level was set at 0.05 and student's t-test was used to compare the data.

## RESULTS

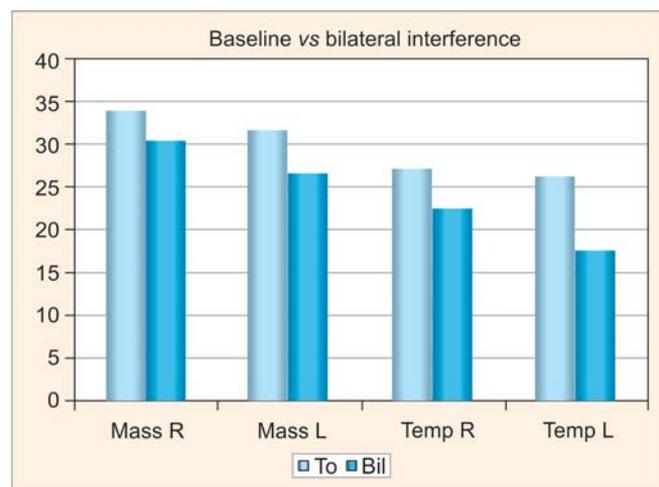
All clinical and research data was entered into a database management system on a personal computer for rapid recall and collection. The data collected for each variable was summarized using descriptive statistics means, standard deviations and student's paired t-test. Student's paired t-test was applied to test the null hypothesis that there was no statistical difference between the results obtained at the four measurement occasions. The significance level was set at  $p < 0.05$ . The results of the questionnaires were inconsistent and uncorrelated with clinical occlusal conditions throughout the study. The EMG activities of group A, subjects who were planned to receive unilateral right interference and group B, subjects who were planned

to receive unilateral left interference are listed in the Tables 1 and 2 respectively. In the single subject, all EMG data were the arithmetic means of the four surface EMG recordings. Student's t-test was used to analyze the data.

1. Comparison of baseline EMG and EMG with bilateral posterior interferences did not reveal any significant difference (Fig. 5). The analysis of questionnaire data did not reveal any significant findings. The patients did not perceive the inaccuracy in their bite.
2. Comparison of baseline EMG and the EMG with unilateral posterior interferences: When the EMG activity at baseline was compared with the EMG activity after the introduction of the unilateral posterior right interferences in group A patients, no significant difference was found between the two (Fig. 6). When the EMG activity at baseline was compared with the EMG activity after the introduction of the unilateral left posterior interferences in group B patients, there was a significant reduction in the EMG activity of the left masseter as compared to the baseline (Fig. 7). The analysis of the questionnaire did not reveal any significant finding.
3. Comparison of baseline EMG and EMG after elimination of interferences did not reveal any significant difference (Fig. 8). The analysis of questionnaire data did not reveal any significant findings. The patients did not perceive the inaccuracy in their bite.

## DISCUSSION

The results of the present study suggest that there was no significant difference in the EMG values of the patients upon



**Fig. 5:** Graphical analysis of the EMG activity at baseline (To) and EMG activity after the introduction of the bilateral interferences (Bil) in all subjects

(Mass R: Right masseter; Mass L: Left masseter; Temp R: Right anterior temporalis; Temp L: Left anterior temporalis)

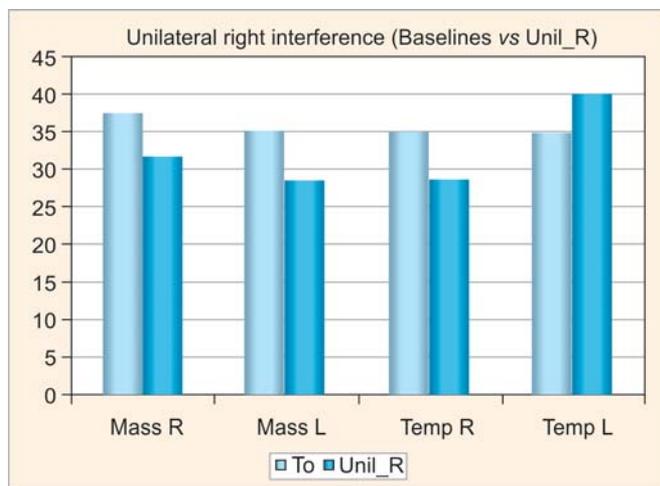
Note: A significance level of 0.05 no significant difference was found between the two.

**Table 1:** EMG value in five patients at baseline (Base EMG), introduction of bilateral interferences (Bilateral interference), introduction of right unilateral interference (Unilateral interference) and elimination of interference (EMG corrected)

Patient no.	Base EMG						Bilateral interference						Unilateral interferences						EMG corrected												
	Mass		Tem		Tem		Mass		Tem		Tem		Mass		Tem		Mass		Tem		Mass		Tem								
	right	left	right	left	right	left	right	left	right	left	right	left	right	left	right	left	right	left	right	left	right	left	right	left							
1	28.9	29.2	12.9	24.8	21.3	23.3	17.2	31.1	12.1	22.0	19.6	40.6	20.7	17.4	15.2	9.9	63.6	43.9	56.4	51.3	69.1	23.1	47.9	70.6	22.6	56.6	27.8	68.5	25.7	43.9	30.0
2	21.3	37.1	23.8	41.8	31.7	37.4	17.4	18.2	14.9	17.5	12.21	42.9	18.9	43.1	29.5	34.0	30.3	25.4	65.9	33.6	30.2	26.4	45.7	28.7	29.7	46.1	19.2	26.3	30.6	45.5	
5	41.6	42.0	16.5	22.3	45.6	58.2	24.7	30.0	31.7	56.6	26.3	42.2	41.3	73.7	21.7	35.7															

**Table 2:** EMG value in five patients at baseline (Base EMG), introduction of bilateral interferences (Bilateral interference), introduction of left unilateral interference (Unilateral interference) and elimination of interference (EMG corrected)

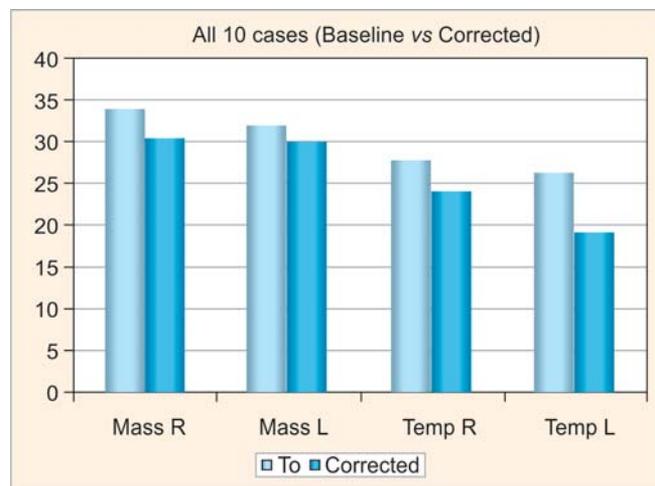
Patient no.	Base EMG						Bilateral interferences						Unilateral interferences						EMG corrected											
	Mass		Tem		Tem		Mass		Tem		Tem		Mass		Tem		Mass		Tem		Mass		Tem		Mass		Tem			
	right	left	right	left	right	left	right	left	right	left	right	left	right	left	right	left	right	left	right	left	right	left	right	left	right	left	right	left		
1	8.2	6.8	15.9	3.5	9.9	6.0	26.2	2.4	8.7	7.1	37.3	6.3	12.0	7.4	41.9	13.3	47.0	38.4	23.5	21.2	35.5	30.0	18.9	39.6	24.9	12.9	8.0	31.1	25.0	
2	27.6	19.5	16.8	11.5	11.4	5.9	9.5	5.0	9.4	6.1	7.3	5.4	26.3	15.4	19.3	13.1	60.8	52.6	28.8	17.2	46.7	40.5	7.3	32.9	26.3	3.6	3.7	6.4	8.1	
5	12.6	24.5	14.2	36.5	4.7	14.3	10.0	15.5	29.7	7.6	10.7	12.0	14.4	18.9	4.1	21.6														



**Fig. 6:** Graphical analysis of the EMG activity at baseline (To) and EMG activity after the introduction of the right interferences (Unil\_R) in five subjects

(Mass R: Right masseter; Mass L: Left masseter; Temp R: Right anterior temporalis; Temp L: Left anterior temporalis)

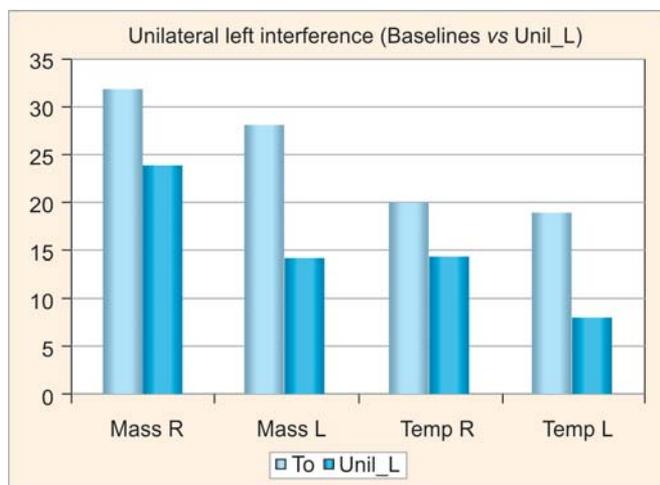
Note: A significance level of 0.05 no significant difference was found between the two



**Fig. 8:** Graphical analysis of the EMG activity at baseline (To) and EMG activity after the elimination of the interferences (Corrected) in all subjects

(Mass R: Right masseter; Mass L: Left masseter; Temp R: right anterior temporalis; Temp L: Left anterior temporalis)

Note: At significance level of 0.05 no significant difference was found between the two



**Fig. 7:** Graphical analysis of the EMG activity at baseline (To) and EMG activity after the introduction of the left interferences (Unil\_L) in five subjects

(Mass R: Right masseter; Mass L: Left masseter; Temp R: Right anterior temporalis; Temp L: Left anterior temporalis)

Note: At significance level of 0.05 a significant difference was found between the left masseter activities

introduction of bilateral interferences. Also, there was no significant difference in the EMG values of patients upon introduction of unilateral right interferences. In the five cases with unilateral left interferences, there was a significant reduction in the EMG activity of the left masseter. This reduction could be an avoidance behavior or the new intra oral stimuli due to the occlusal interferences may have activated the nociceptive afferents which could have inhibited muscle contraction as was also observed by Nergiz et al and Sohn et al in their study.<sup>12-14</sup> There was also no significant difference in the EMG values at baseline and

after the removal of the interferences. The analysis of the questionnaires did not reveal any significant findings. The patients investigated in the present study were healthy physiologically and psychologically and the results may be different in psychologically distressed individuals.<sup>12</sup>

To the author's knowledge, this is the first short-term study investigating the effect of introduction of experimental occlusal interference on the EMG activity of the masseter and temporalis on edentulous subjects; therefore, the findings cannot be directly compared with those of previous studies. This should be considered a pilot study and the results of this study should be interpreted with caution owing to the small sample size and the variability in the subject population. Also adaptation of the neuromuscular system takes an extended time and may be a determinant factor in influencing EMG activity and this aspect can change the results.<sup>15</sup>

Also investigation for a longer duration on the effect of the occlusal interference may result in more conclusive results. The limitation of the surface EMG recording cannot be overlooked even though methods were used to control the influence of interferential factors; for example, maintaining the same positions of the electrodes in different recordings.

## CONCLUSION

The results of the present study suggest there was no significant difference in the EMG values of the patients after the introduction of the bilateral interferences and unilateral right interferences.

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