



## **Influence of Occlusal Plane Orientation on Sound Production and Electromyographic Activity in Complete Denture Wearers**

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### **ABSTRACT**

**Purpose:** The aim of the study was to evaluate the effect of two different occlusal plane orientations (Ala tragus line and Retro molar pad) on electromyographic activity of masseter and anterior temporalis muscles and sound production in complete denture wearers. **Material and methods:** Ten completely edentulous patients' ages ranged from 55-65years. All patients had received two dentures first denture was made according to Ala tragus line (Group I) and second denture was made according to retro molar pad (Group II). Electromyographic activity was evaluated for both groups after one week, one month and three months with one week washing period between the two groups. While Speech analysis was evaluated after one week and one month for both groups. **Results:** The results of this study showed that no significant differences between both groups regarding to Electromyographic activity and phonetics. **Conclusion:** Based on the results of this study no single technique seems completely accurate to determine the exact occlusal plane. A combination of different landmarks along with a good clinical assessment should be considered in order to determine the location of the occlusal plane in edentulous patients.

### **KEYWORDS**

*Complete dentures,  
Occlusal plane orientations,  
Electromyographic activity and  
Phonetics*

### **INTRODUCTION**

Teeth play important functional and esthetic roles. A beautiful, radiant smile that does show healthy and natural teeth is one of the greatest assets any person can ever have. Although the face represents only a small proportion of the surface of the body, it embodies our

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social identities. Teeth are the most important part of the oral cavity mainly because the functions of the teeth in mastication, esthetics, and speech cannot be replaced. Tooth loss is a global public health issue. Dentures can help people through Mastication & Aesthetics & Pronunciation and Self-esteem<sup>(1)</sup>.

Locating the occlusal plane is considered one of the essential clinical steps in recording jaw relations in complete dentures<sup>(2)</sup>. The occlusal plane position is considered to be the primary link between function and esthetics. Occlusal plane is defined according to the glossary of prosthodontic terms as "the average plane located by the incisal edges and occlusal surfaces of the teeth<sup>(3)</sup>. Generally, it is not a plane but represents the planar mean of the curvature of these surfaces"<sup>(4)</sup>.

The location of occlusal plane in complete dentures should be close enough to the past plane that was previously located by the natural teeth. Such position of the occlusal plane offers natural performance of the tongue and cheek muscles, thus increasing the stability of the denture. Many authors have assumed different landmarks for locating the occlusal plane. Different landmarks have been used to locate the occlusal plane in the lower arch e.g. retro molar pad, lateral borders of the tongue, the buccinators groove and commissure of the lips<sup>(5)</sup>. Different landmarks have been used to locate the occlusal plane in the upper arch e.g. Parotid papilla, Hamular notch- incisive papilla plane and Ala-tragus line<sup>(6)</sup>.

Loss of teeth cause decreased capacity of different functions of stomatognathic system like tactile sensation, chewing efficiency and occlusal forces<sup>(7)</sup>. Different methods are valid for the stomatognathic system evaluation. Electromyography (EMG) is known for recording and evaluation of the basic electrical functions of skeletal muscle through superficial or needle electrodes. EMG is largely used in clinical and research work<sup>(8)</sup>.

Complete loss of teeth may lead to a speech problem by altering dental articulation places. This

may decrease speech quality. Speech production has a great impact on patients' overall satisfaction with dentures<sup>(9)</sup>. Respiration, phonation, resonance and articulation constitute the primary processes involved in speech production. These processes along with the functions of the innervation systems must interact and interrelate in a synergistic manner for normal speech to occur. There are many factors that affect phonation as denture thickness, post dam area, vertical dimension and occlusal plane orientation.

The aim of the study was to evaluate the effect of two different occlusal plane orientations (Ala-tragus line and Retro molar pad) on Electromyographic activity and phonetics.

## MATERIAL AND METHODS

Ten completely edentulous patients were selected from the Outpatient Clinic Prosthodontics Department. Faculty of Dental Medicine for Girls, Al-Azhar University. Patient's medical and dental history and clinical examination were carried out. All patients were males aged between 55-65 years old. Each patient received two maxillary and mandibular complete dentures.

Group I dentures: upper and lower complete dentures fabricated with occlusal plane made according to Ala tragus line technique. Group II dentures: upper and lower complete denture fabricated with occlusal plane made according to Retro molar pad technique.

### Steps for complete denture construction for group I & II:

For construction of both dentures, preliminary alginate impression were taken and poured into plaster of Paris. Special trays were constructed for secondary impression and secondary impression was taken. Trial denture bases made of auto polymerizing acrylic resin and occlusion rims were constructed on stone master casts made from zinc

oxide and eugenol secondary impression material. The trial denture base extension, retention and stability were checked in patient's mouth.

### **Jaw relation for group I:**

Occlusal plane anteriorly was adjusted to be parallel to inter pupillary line and 1-2 mm of wax appear when patient smiles. Occlusal plane posteriorly was made parallel to Ala tragus line. A maxillary face bow record using (BIOART - A7-PLUs face bow) was made to mount the maxillary cast on semi adjustable articulator using wax wafer technique making two sharp (V) notches in the upper occlusal rim on the molar / premolar area of each side. Vertical dimension was measured at rest and at occlusion. Centric relation was recorded and maxillary and mandibular casts were mounted on (BIOART - A7-PLUS semi adjustable articulator).

### **Jaw relation for Group II:**

The lower wax rim was adjusted to coincide with two-thirds the height of the retro molar pads posteriorly and the corners of the mouth anteriorly. Then the upper occlusal rim was adjusted to achieve simultaneous and even contact with the lower occlusion rim at the exact occlusal vertical dimension. A maxillary face bow record was done to mount the maxillary cast on semi adjustable articulator. Two sharp (V) notches on the molar / premolar area of each side were done in the mandibular wax rim. The upper wax rim was softened in order to record Centric occluding relation. Centric occluding relation was recorded at the exact occlusal vertical dimension. Both upper and lower casts were mounted on BIOART - A7-PLUS Semi adjustable articulator.

### **Electromyographic activity measurements:**

EMG was measured after one week and one month and three months for each patient with both dentures with one week washing period between both dentures.

In our study Surface EMG recordings were made for masseter and anterior temporalis using computer electromyography based data acquisition system and were expressed by root mean square (RMS) as (Fig. 1). In order to decrease patient variability a standard amounts of banana and carrots were used which represent examples of hard and soft food. All the patients during recordings were asked to seat in unsupported head posture and to keep a naturally erect posture. Alcohol swab was used for cleaning skin to decrease skin resistance to electric connection before electrode placement. Electrode gel was applied to skin for improving conductivity. The electrodes were contacted to the skin over the palpated main bulk of the contracted muscle and located parallel to the general direction of the muscle fibers.

### **Spectral analysis**

Speech samples were recorded using Computerized Speech Lab (CSL) (spectrogram) (CSL Kay Elemetrics Model 4300, USA) in Phoniatic Unit, ENT Department, Specialized Ain-Shams Hospital. All recordings were done in a quiet room as follows: The patient was seated in the chair in the upright position and was allowed to read sentences in comfortable amplitude and pitch. Using a High-quality dynamic microphone at chest level 10 cm in front of patient. The Labio-dental consonants were selected, as /f/ and /v/ phonetic probes are generally recommended for assessment of the position and length of restored front teeth. The sounds were selected in a paragraph containing the required consonant sound between two vowels as (fafa) and (vava). The spectral analysis was not made on the entire word of the paragraph but only on word fragments that allow observations of these changes as /f/ and /v/ sounds .voice onset time of both /f/ and /v/ sounds were measured in milliseconds as (Fig. 2). Each denture was evaluated two times, first time after one week and second time after one month.

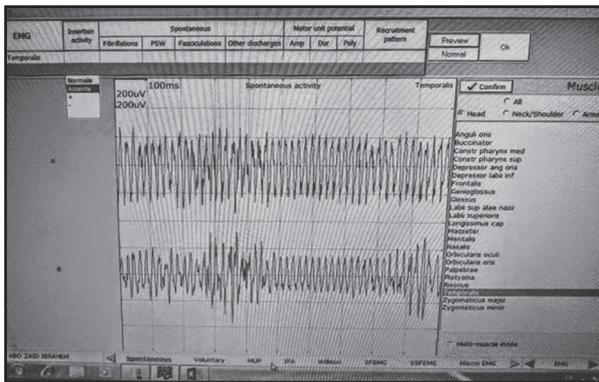


Figure (1) EMG for Temporalis muscle

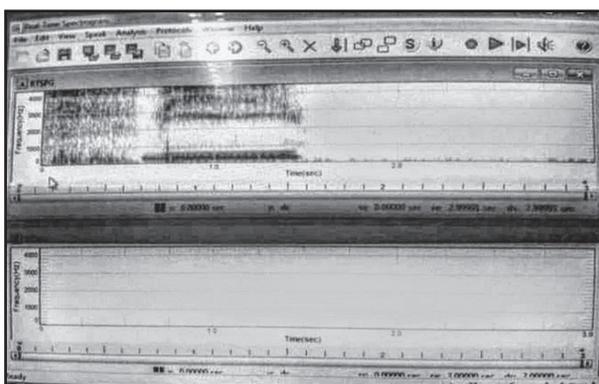


Figure (2) Spectrogram analysis of /f/ sound

**Statistical analysis**

Numerical data were displayed as mean and standard deviation (SD) values and were examined for normality by screening distribution of the data, calculating the mean and median values and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Intra and intergroup comparisons were done using repeated measures ANOVA followed by pairwise comparisons utilizing multiple paired t-tests with Bonferroni correction. The significance level was set at  $p \leq 0.05$  for all tests. Statistical analysis was performed with IBM® SPSS® Statistics Version 26 for Windows.

**RESULTS**

**Comparison between muscle activities & phonetics of the two groups:**

After one week, one month and three months during hard and soft food chewing of masseter and

temporalis muscle activity, it was found that the highest mean value recorded for group I & group II after one week followed by after one month while the lowest value after three months follow up in both dentures. The difference between groups was statistically in-significant difference ( $P$ -value  $> .05$ ), as listed in (Table 1).

There was no significant difference between group I and group II at voice onset time for both sounds /f/ and /v/ at different follow up intervals as showed in (Table2).

**Table (1)** Mean, Standard deviation (SD) values of EMG readings percentage change (%) in different groups

Muscle and food	Follow-up	Groups (mean±SD)		p-value
		Group (I)	Group (II)	
Masseter hard food	1 week-1 month	8.43±1.89	8.86±3.56	0.765ns
	1week-3 months	17.88±4.23	17.88±4.14	0.991ns
Masseter soft food	1week-1 month	12.06±7.33	11.84±5.33	0.837ns
	1week -3 months	22.26±9.01	25.48±9.92	0.407ns
Temporalis hard food	1week-1 month	12.07±11.17	16.25±13.04	0.181ns
	1 week-3 months	23.36±11.54	28.83±11.52	0.112ns
Temporalis soft food	1week-1 month	18.91±8.26	17.97±8.77	0.766ns
	1 week-3 months	32.90±8.54	32.24±10.05	0.752ns

\*; significant ( $p \leq 0.05$ ) ns; non-significant ( $p > 0.05$ )

**Table (2)** Mean, Standard deviation (SD) values of voice onset time (m/s) in different follow-up intervals

Sounds	Groups	Follow-up (mean±SD)		p-value
		1 week	After 1 month	
(V) sounds	Group (I)	0.044±0.004	0.041±0.004	<0.001*
	Group (II)	0.043±0.004	0.040±0.004	<0.001*
(F) sounds	Group (I)	0.048±0.004	0.046±0.004	<0.001*
	Group (II)	0.050±0.004	0.046±0.004	<0.001*

\*; significant ( $p \leq 0.05$ ) ns; non-significant ( $p > 0.05$ )

## DISCUSSION

Newly constructed dentures or changes in occlusion and vertical dimension have a positive effect on the patient by decreasing muscle effort throughout chewing without affecting masticatory function. The reduction in muscular activity mostly lead to less tissue damage and finally may reduce residual ridge resorption and new complete denture permits neuromuscular reprogramming, that helps in creating muscular balance of the masticatory system<sup>(7)</sup>.

In Group I: The occlusal plane of the maxillary rim was adjusted so that it was parallel to the interpupillary line anteriorly. Inability to mimic these guidelines will lead to an offensive, unbalanced appearance of the final dentures.<sup>(10)</sup> A useful guideline for sagittal orientation of the occlusal plane is the Ala-tragus plane; it is considered a popular technique for occlusal plane orientation determination.<sup>(5)</sup> Numerous authors have stated that all the three parts of the tragus i.e. superior, middle and inferior have been confirmed to be guides for occlusal plane orientation in edentulous patients. This extra-oral landmark is dependable as both its ends do not vary with age<sup>(5)</sup>. Group II: The retro molar pad is a pear shaped area that forms only following the elimination of the most distal molar<sup>(11)</sup>. Wright concluded that the retro molar pad is a relative constant landmark even in patients with progressing ridge resorption. Apart from this it is a good landmark for the orientation of occlusal plane in edentulous patients as its place still stable even after loss of natural teeth; therefore retro molar pad has an important role in locating the occlusal plane<sup>(11)</sup>. Wright concluded that the mandibular first molar is usually at a level equivalent to two third of the height of retro molar pad<sup>(11)</sup>. So retro molar pad area has a significant role and is an important landmark in construction of removable dentures but still there is dependable but not enough information on various bone, mucosa, muscle tissue shapes, sizes and distribution at the mandibular areas in edentulous patients<sup>(11)</sup>.

The results of the current study demonstrated that no significant difference between Group I and Group II in Electromyographic activity and phonetics test. In electromyographic activity there was significant decrease in muscles activity with the highest value after one week then followed by one month with the lowest value after three months. New prostheses have favorable impact on the muscle activity of the patient. However, an adaptation period of the muscle fibers to the new prosthesis is required<sup>(12)</sup>. Goiato et al. come to conclusion that a new denture permits neuromuscular reprogramming, which allows for muscular balance of the masticatory system which is gradually caused by time<sup>(12)</sup>.

There were no significant difference between group I and group II in pronunciation of both sounds /f/ and /v/ at different intervals. But there was a significant decrease of mean value of voice onset time with the greatest value after one week with the lowest value after one month in both sounds /f/ and /v/. Speech distortions may appear after oral rehabilitation with removable dentures, in the course of time these changes become less evident or disappear completely<sup>(13)</sup>.

V. Yu. Kurlyandsky defines three sequential stages of denture adaptation. The first stage of discomfort starts on day one from denture delivery to the patient. The second stage is partial suppression that lasts from the first to the fifth day after denture delivery. The final stage is full suppression that starts from the fifth to the thirty-third day after denture insertion<sup>(14)</sup>.

## CONCLUSION

Different landmarks are valid in order to locate the occlusal plane in edentulous patients. However, according to various studies, no single technique seems totally accurate to locate the occlusal plane. So a combination of various landmarks along with a good clinical assessment should be considered for the determination of the occlusal plane in edentulous patients. It is also advisable that occlusal plane should be selected on the basis of anatomical landmarks, esthetics, phonation, comfort and function.

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