

SHORT TERM EVALUATION OF INTEROCCLUSAL DISTANCE DURING SPEECH AFTER NEW REMOVABLE PROSTHESIS INSERTION

AValiação A Curto Prazo da Distância Interocclusal Após a Instalação de Novas Próteses Removíveis

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The aim of this study was to evaluate the interocclusal distance during the pronunciation of /m/ and /s/ sounds from Portuguese Language, in partially edentulous patients before and after new partial and total prosthesis installation. The subjects were divided into two groups: Experimental group, consisting of 9 patients entirely edentate in the upper maxillary arch and classified as Kennedy Class I in the lower arch; and Control group, consisting of 9 totally dentate patients. The subjects from the first group had their worn out dentures changed and the occlusal vertical dimension (OVD) corrected. A magnetic method of jaw tracking was used to measure the interocclusal distance (mm) during pronunciation of those phonemes. Comparison between groups, by *t* test, showed significant difference ($p < 0.05$) for /m/ sound in all periods of time: before prosthesis installation – T0 (3.38 ± 1.23), immediately – T1 (2.15 ± 1.06), six hours – T2 (3.41 ± 1.33), twenty-four hours – T3 (2.92 ± 0.92), two days – T4 (4.80 ± 1.93), one week – T5 (3.87 ± 1.43), two weeks – T6 (3.03 ± 0.96), one month – T7 (3.03 ± 0.96), two months – T8 (4.47 ± 1.45) and three months – T9 (4.33 ± 2.56), except for six months – T10 after prosthesis installation. For /s/ sound phoneme the results were different ($p < 0.05$) between the groups in T1 (2.89 ± 1.33), T2 (3.37 ± 1.22), T3 (3.19 ± 1.06), T4 (3.86 ± 1.21), T5 (3.83 ± 1.32), T6 (3.27 ± 1.10), T7 (3.37 ± 0.99) and T10 (3.84 ± 1.38) after oral rehabilitation. The *paired-t* test, for means comparison between before and after prosthesis insertion, indicated significant differences ($p < 0.05$) for /m/ sound only in T1, and for /s/ sound in T1, T2, T3, T6, T7 and T10. It was concluded that new prosthesis insertion, correcting the OVD, changes the interocclusal distance, and for /m/ sound this distance could be recovered after six months of prosthesis wearing.

UNITERMS: Occlusal vertical dimension; Speech; Interocclusal distance.

INTRODUCTION

Increasing occlusal vertical dimension (OVD) can affect speech articulation of some sounds⁸. Silverman¹³ (1953) was the first to suggest that a relationship may exist between the closest speaking space (CCS) and the occlusal vertical dimension. He noted that the sibilant sounds from English language produced the closest speaking space, but stated that

this measure must not be confused with the interocclusal rest space (IORS), because these measures are different for the same patient.

However, the hypothesis that the CCS could be smaller than IORS have been contested, and recent studies have verified that there are no statistical differences between these two measures during the pronunciation of some sounds¹¹, because they are not different physiologic phenomena¹². In addition, the

minimal electromyographical activity (EMG) of some masticatory muscles does not usually correspond to the clinical rest position¹⁰.

It is recognized that the CSS can vary among idioms and according to Lu, et al.⁹ (1993) there are differences in the CSS between English and Cantonese languages. As the CSS is produced during sibilants sounds pronunciation^{9,12,14}, some authors considered it as being equivalent to the interocclusal distance during speech of /m/ and /s/ phonemes.

Current clinical and research emphasis is primarily on English language. Because every person who wears new dentures must adapt to OVD and speech changes, additional descriptive clinical data are needed to assess the time and relative significance of this occurrence.

The aim of this study was to evaluate the short-term effects of increasing occlusal vertical dimension on interocclusal distance (IOD), during the speech of /m/ and /s/ sounds from Portuguese language, by the new partial and total removable prosthesis insertion, using a magnetic method of jaw tracking.

MATERIALS AND METHODS

Subjects

Twenty-one volunteers participated in this study and were divided into two groups. Only healthy subjects without systemic disease were included and none suffered from any speech defect or had a history or symptoms of temporomandibular dysfunction. The first group, or control group, consisted of 2 male and 7 female undergraduate dental students and employees at the School of Dentistry of Piracicaba, University of Campinas (mean age 38 years). This entire group had intact dentitions, except where extractions for orthodontic realignment had been performed or third molars were missing.

The second, or experimental group, consisted of 1 male and 11 female, who were selected from those treated at the Dental Clinic from the School of Dentistry of Piracicaba (mean age 53 years). The criteria for selection to this group were that each subject should: (1) have previously worn a conventional upper complete denture; (2) have OVD altered by the use of old and worn out dentures; and (3) be partly dentate in the lower dental arch, classified as Kennedy Class I. All selected subjects signed a consent form.

Removable Prosthesis Preparation

After selection, the patients from the experimental group received new upper complete dentures and lower partial dentures prepared with a heat polymerized acrylic resin (Clássico Artigos Odontológicos Ltda., São Paulo, Brazil), according to the conventional technique. All lower partial denture frameworks were prepared in a cobalt-chromium (Co-Cr) (Degussa – Hüls AG, Hanau, Germany) and the major connector planned for all of them was the lingual bar. The OVD was determined by two methods: (1) Willis and (2) Turner & Fox. These two methods were applied for each patient, and the OVD used was that when an agreement value was obtained from both methods.

After prosthesis insertion, three patients of experimental group abandoned the research, thus the study was conducted with a total of 18 subjects, comprising nine patients in each group.

Interocclusal Distance Evaluation

The magnetic method of jaw tracking was used to record mandibular movement to determine the interocclusal distance for both control and experimental groups, before and after prostheses insertion. The records were obtained by a Kinesiograph (K6-I Evaluation System, Myotronics-Noromed Inc, Seattle, WA, U.S.A.) using a scan number 3 with 5mm of magnification. This method is an integrated computerized system designed for the specific purpose of monitoring mandibular movement in three dimensions. The specific mechanisms utilized by the K6-I System for tracking movement are derived from the field of aelectromagnetic proximity measurement.

The subjects worn an array of sensors suspended on a lightweight headgear, which is sensitive to alterations of a magnetic field (Figure 1). A magnet was affixed in the patient's labial vestibule, just below the mandibular incisors (Figure 2). The sensor array then tracks the movements of the mandible from the incisor point.

Therefore, the subjects were placed with the Frankfort plane horizontal, with a firm headrest, and instructions to avoid head movements. They were asked to close to the maximum intercuspal position (MIP), this position was explained and demonstrated prior to the experiment. They were then asked to speech for 10 times the phoneme /m/ from the Portuguese language at normal conversation rate and volume, until the equipment provided the interocclusal distance values, and then asked to return to the MIP

position. The same procedure was followed in order to record the interocclusal distance for /s/ speech sound.

The interocclusal distance was determined for the experimental group, in the following periods of time: immediately before prosthesis insertion (T0), but without the old prosthesis in the mouth; immediately after the new prosthesis insertion (T1); six hours after (T2); 24 hours after (T3); two days after (T4); one week after (T5); two weeks after (T6); one month after (T7); two months after (T8); three months after (T9); and six months after (T10) prosthesis installation. Since the patients of control group did not receive any prosthetic treatment, they were evaluated in a single period of time.

Statistical Analysis

The means of the measurement of the interocclusal distance recorded for /m/ and /s/ sounds from the control group was compared with those obtained from experimental group by *t* test at 95% of confidence

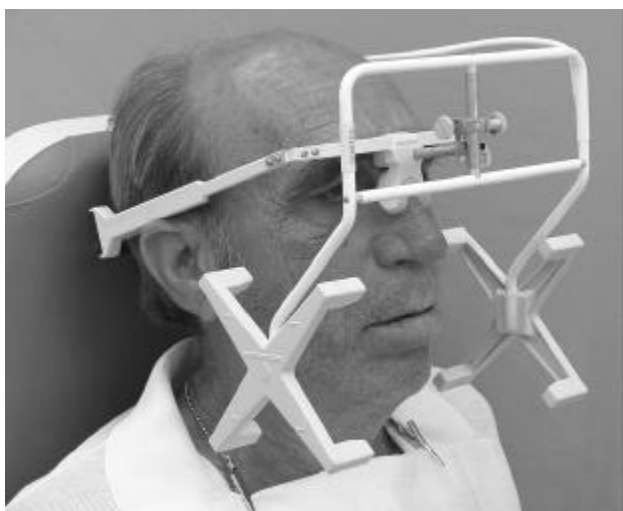


FIGURE 1- Subject using an array of magnetic sensors.



FIGURE 2- Magnet affixed in the patient's labial vestibule.

level. The mean value of interocclusal distance before the new prosthesis insertion (T0) was then compared with those recorded after several times of prosthesis insertion (T1, T2, T3, T4, T5, T6, T7, T8, T9 and T10) using a *paired t* test, at the same level of confidence.

RESULTS

Table 1 shows the means of interocclusal distance (mm) determined for each period of time, during /m/ sound speech for control and experimental groups. There was a variation between periods of time ranging from 2.15 to 5.13. There was statistical difference, $p < 0.05$, for the interocclusal distance values between the control and experimental groups, in all periods of time studied, except for T10, six months after prosthesis installation. A *paired t* test showed a statistically significant difference, $p < 0.05$, for the mean values of the interocclusal distance between T0 and T1 only.

Table 2 shows the comparisons of interocclusal distance values obtained during pronunciation of /s/ sound. The values ranged from 5.04 to 2.89 with the time. There were statistical differences, $p < 0.05$, between control and experimental groups in the following periods of time: T1 (immediately after prosthesis insertion), T2 (six hours after), T3 (24 hours after), T4 (two days after), T5 (one week after), T6 (two weeks after), T7 (one month after) and T10 (six months after). A *paired t* test showed differences, $p < 0.05$, between the values obtained in T0 (before prosthesis insertion) and T1, T2, T3, T6, T7 and T10.

DISCUSSION

A newly acquired prosthesis or orthodontic appliance requires a period of physiologic adjustment by the patient. This adjustment, or adaptation is accomplished through functional alterations, including efficient chewing, swallowing and speech articulation⁶.

Interocclusal distance during /m/ and /s/ sounds from Portuguese language pronunciation, obtained before and several periods after removable prosthesis insertion, were compared with those obtained from complete dentate patients. This comparison was an attempt to verify in which period of the time similar measures between the groups could occur, indicating a possible phonetic adaptation to the new prosthesis.

The results from /m/ sound (Table 1) indicated significant difference ($p < 0.05$) for IOD values between

experimental and control groups only after six months of prosthesis installation (T10). It is likely that the wearer of a new mandibular partial removable prostheses, and a maxillary complete denture needs nearly 6 months to pronounce /m/ phoneme similarly

to a complete dentate patient.

According to Mehringer¹¹ (1963) the nasal sonant sounds need an incisal separation of 2 to 4 mm, equivalent to the IOD when the mandible is physiologically at rest, and are emitted through the

TABLE 1- Means and Standard Deviations of Interocclusal Distance (mm) During /m/ Sound Pronunciation, Before and After New Prosthesis Insertion.

Time	/M/ PHONEME	
	Experimental Group Mean (SD)	Control Group Mean (SD)
		6.94 (2.17)
T0 (Before rehabilitation)	3.38 (1.23) *	
T1 (Immediately after)	2.15 (1.06) * †	
T2 (Six hours after)	3.41 (1.33) *	
T3 (24 hours after)	2.92 (0.92) *	
T4 (Two days after)	4.80 (1.93) *	
T5 (One week after)	3.87 (1.43) *	
T6 (Two weeks after)	3.03 (0.96) *	
T7 (One month)	3.03 (0.96) *	
T8 (Two months after)	4.47 (1.45) *	
T9 (Three months after)	4.33 (2.56) *	
T10 (Six months after)	5.13 (2.25)	

Means followed by * are different ($p < 0.05$) from the control group by *t* test

Means followed by † are different ($p < 0.05$) from T0 (before rehabilitation), by *t-paired* test.

TABLE 2- Means and Standard Deviations of Interocclusal Distance (mm) During /s/ Sound Pronunciation, Before and After New Prosthesis Insertion.

Time	/M/ PHONEME	
	Experimental Group Mean (SD)	Control Group Mean (SD)
		5.61 (2.04)
T0 (Before rehabilitation)	5.04 (1.49)	
T1 (Immediately after)	2.89 (1.33) * †	
T2 (Six hours after)	3.37 (1.22) * †	
T3 (24 hours after)	3.19 (1.06) * †	
T4 (Two days after)	3.86 (1.21) *	
T5 (One week after)	3.83 (1.32) *	
T6 (Two weeks after)	3.27 (1.10) * †	
T7 (One month)	3.37 (0.99) * †	
T8 (Two months after)	3.93 (1.42)	
T9 (Three months after)	4.01 (1.62)	
T10 (Six months after)	3.84 (1.38) * †	

Means followed by * are different ($p < 0.05$) from the control group by *t* test.

Means followed by † are different ($p < 0.05$) from T0 (before rehabilitation), by *t-paired* test.

nose. In the format of /m/ sound, the closed lip position obstructs the oral port. The tongue rests on the floor of the mouth creating a space between it and the palate. This space acts as a resonating chamber for the low frequency vibration in the speech. Therefore, with the new prosthesis installation, besides the OVD, this resonating chamber space was altered, originating speech problems during the first periods after prosthesis insertion.

Hamletm, Stone⁷ (1982) stated that dentate patients need a period of two or more weeks in order to adapt to dimensional and shape changes of the palate and alveolar region, and return to speech properly. In addition, according to Hammond and Beder⁸(1984) the loss of teeth alters not only the dimensions of the oral cavity, but also results in loss of the tooth proprioception, which exerts a physiologic influence on speech articulation. Considering that patients evaluated in this study were complete-denture wearers, they consequently showed alterations in both dimension of the mouth and proprioception mechanism. Therefore, they would need a longer period of time, nearly 6 months in order to exhibit the same interocclusal distance during /m/ sound pronunciation, as the dentate patients.

Comparison of IOD values for /m/ sound, between before and after prosthesis insertion (Table 1), revealed statistical difference ($p < 0.05$) only for T1 (immediately after prosthesis installation). This means that immediately after prosthesis insertion, the IOD was altered and in the following periods of time it returned to the same values as before rehabilitation. As the articulation of /m/ sound depends mainly on the space created between the tongue and palate, the patient should be able to pronounce this phoneme reproducing the IOD value obtained before oral rehabilitation, in a short period of time. This fact does not mean that this measure is equal to that obtained from the control group patients.

To speech /s/ sound, the mandible should be depressed and slightly protracted until an incisal separation of 1 to 1.5 mm is attained¹¹. The tongue rests against the lingual of the lower anterior teeth and at the same time contacts the lateral portions of the palate. Thus, the emission of this sound, a minimal incisal separation must exist, and consequently the position of anterior upper and lower teeth is an important factor.

However, the results from the comparison between experimental and control groups (Table 2) showed that the IOD values obtained during the pronunciation of this sibilant sound were not statistically different ($p > 0.05$) before prosthetic treatment (T0). This result

could be related to the space needed to speech this sound. In the experimental group, before prosthesis installation, this space occurred between superior alveolar ridge and incisal surface of anterior lower teeth. Probably, this space measure is similar to that obtained from dentate patients, and it is the most relevant change caused by a prosthesis insertion than any others.

It can also be noted in Table 2 that after prosthesis insertion, from T1 to T7, the results were different ($p < 0.05$) between the groups. Again, this could be explained by the oral cavity dimensions and OVD alterations right after prosthesis insertion. Along the time, from T1 to T7, the progressive neuromuscular adaptation⁸ could allow the patient to adapt to a new OVD, recovering the IOD needed to speech /s/ sound. The IOD recovering could be complete after two or three months of prosthesis insertion, since the values were not different ($p > 0.05$) between groups.

However, as the /s/ sound is more affected than the /m/ sound after prosthesis treatment^{3,14,15}, the total adaptation could not be complete, because after six months (T10), the results were again statistically different ($p < 0.05$) between the groups. Therefore, the speech adaptation for sibilants sounds is probably more complex, and the patient needs a longer period of time to recover the IOD, required to emit this sound.

The analysis of IOD values obtained for the experimental group, showed significant differences ($p < 0.05$) between T0 (before treatment) and T1, T2, T3, T6, T7 and T10 periods of time after prosthesis insertion. This could be expected, since the speech adaptation to /s/ sound is more complex and needs a longer period of time to be evaluated.

The IOD values for both sounds obtained for the control group in this study, were different from those found by Lu, et al.⁹(1993), Burnett and Clifford¹ (1993) and Burnett²(2000), probably due the different idioms studied. In addition, according to George⁵ (1983), IOD for /s/ sound can vary depending on its position in a word or phrase. This present study has evaluated the emission of a phoneme alone, and this fact could contribute to explain the differences found.

Besides all factors previously reported, the patient emotional behavior in relation to a prosthetic treatment can also influence the speech patterns^{4,15}. Patients who psychologically accepted their dentures, shortly after they started wearing them, also had fewer speech difficulties than those who did not accept the dentures. Thus, the speech alterations after removable or fixed oral rehabilitations are complex and need further studies involving longer periods of evaluation.

CONCLUSIONS

Within the limitations of this investigation, the following conclusions can be drawn:

1. The occlusal vertical dimension correction by a new complete upper dentures and partial removable lower prosthesis insertion, can alter the interocclusal distance needed to speech /m/ and /s/ sounds from Portuguese language.

2. The interocclusal distance needed to speech /m/ sound from Portuguese language was recovered after six months of prosthesis wearing.

3. The freeway space necessary for /s/ sound pronunciation needs a longer period of time to be recovered.

RESUMO

O objetivo deste estudo foi avaliar a distância interoclusal durante a pronúncia dos fonemas /m/ e /s/ da Língua Portuguesa em pacientes parcialmente desdentados antes e após a instalação de novas próteses parciais inferiores e totais superiores. Os voluntários foram divididos em dois grupos: Grupo Experimental: composto por 9 pacientes totalmente desdentados na arcada dentária superior, e classificados como classe I de Kennedy na arcada dentária inferior; e Grupo Controle, composto por 9 pacientes totalmente dentados. Os voluntários do primeiro grupo tiveram suas próteses antigas substituídas e a dimensão vertical de oclusão (DVO) corrigida. O método eletromagnético do traçado dos movimentos mandibulares foi utilizado para mensurar a distância interoclusal (mm) durante a pronúncia dos referidos fonemas. A comparação dos resultados entre os grupos (teste "t") demonstrou diferença significativa ($p < 0,05$) para o fonema /m/ em todos os períodos de tempo avaliados: antes da instalação das próteses – T0 ($3,38 \pm 1,23$), imediatamente – T1 ($2,15 \pm 1,06$), seis horas – T2 ($3,41 \pm 1,33$), 24 horas – T3 ($2,92 \pm 0,92$), dois dias – T4 ($4,80 \pm 1,93$), uma semana – T5 ($3,87 \pm 1,43$), duas semanas – T6 ($3,03 \pm 0,96$), um mês – T7 ($3,03 \pm 0,96$), dois meses – T8 ($4,47 \pm 1,45$) e três meses – T9 ($4,33 \pm 2,56$), exceto para o tempo de seis meses – T10, após a instalação das próteses. Para o fonema /s/, os resultados indicaram diferenças estatísticas ($p < 0,05$) entre os grupos em T1 ($2,89 \pm 1,33$), T2 ($3,37 \pm 1,22$), T3 ($3,19 \pm 1,06$), T4 ($3,86 \pm 1,21$), T5 ($3,83 \pm 1,32$), T6 ($3,27 \pm 1,10$), T7 ($3,37 \pm 0,99$) e T10 ($3,84 \pm 1,39$) após a reabilitação oral. O teste "t-pareado", utilizado para a comparação das médias entre antes e após a inserção das próteses,

indicou diferenças significantes ($p < 0,05$) para o fonema /m/ somente em T1, e para o fonema /s/ em T1, T2, T3, T6, T7 e T10. Pode-se concluir que a instalação de novas próteses, corrigindo a DVO, altera a distância interoclusal, e que para o fonema /m/ esta distância pode ser recuperada após 6 meses de uso das próteses.

UNITERMOS: Dimensão vertical de oclusão; Fala; Distância interoclusal.

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