

Original Article

A Correlative Analysis of Occlusal Schemes on Chewing Efficiency, Muscles Kinetics, And Patient's Satisfaction In Complete Dentures Wearers: A Cross-Over Study

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Abstract:

Aim: This study aimed to investigate the correlation between chewing efficiency and muscle kinetics using balanced occlusion and group function occlusion.

Methodology 20 edentulous patients were selected and given a complete denture with balanced occlusion(Group A) for one month, and then they were recalled the first denture collected and a new denture using group function (Group B) was given for one month. Chewing efficiency was measured using the standardized chewing test units (SCT) and muscle kinetics was measured using Electromyography (EMG). After both follow up periods, patients were asked about their satisfaction with both groups using the visual analog system (VAS).

Results In Balanced occlusion there was a negative correlation of -0.594 between chewing efficiency and muscle kinetics, which means they are directly proportion to each other.. However, in group function occlusion; there was a positive correlation of 0.463, which means are inversely proportion. On the VAS scale patient satisfaction recorded 9 (highly satisfied) with the group A and 5 (Neutral) with group B.

Conclusions It can be concluded from this study that the balanced occlusion scheme allowed better chewing efficiency, with lower muscle kinetics, and higher patients' satisfaction.

Keywords: Balanced occlusion; Chewing efficiency; Complete denture; Muscle kinetics

Introduction

The basic fundamentals of life for all living organisms are water and food. In chewing of food and deglutition we need teeth to perform this basic physiologic process. But what about people who have lost their teeth and can't perform this daily process?

The Complete denture has been regarded as the mainstay treatment option for completely edentulous patients. However,

Patients' satisfaction with complete denture usually doesn't meet with previous expectations.^{1, 2} As the complete denture is a removable prosthesis, gaining entirely its support from soft mucosa so, movement is expected. This results in inefficient chewing of food. One of the solutions to improve these problems is, arranging the teeth in the best position in relation to the supporting structures. Occlusal schemes should be harmonious with the surrounding muscles, in order to allow prime

muscle performance, to provide greatest enhancement of mastication, speech and esthetics.^{3,4}

Several occlusal schemes have been suggested to improve position of teeth in relation to its functions. The most widely used occlusal scheme is group function. Arranging of teeth is done on a fixed condylar articular (Mean Value) according to Bonwill triangle and according to an average measure of condylar angle, incisal angle, and inter-condylar distance. The patients' individual measures should be close to these averages in order for the denture to be stable. Balanced occlusion is another scheme; balanced Occlusion is defined as the bilateral, simultaneous, anterior, and posterior occlusal contact of teeth in centric and eccentric positions. Individual measures of condylar angle, incisal angle and lateral condylar angle are taken for every patient. It can be generated using a face bow and a semi-adjustable articulator.⁵⁻⁸ Balanced occlusion provides stability in complete dentures and decrease the load on the supporting structures.⁹

Muscles kinetics is directly related to the type of occlusion found by nature or profound with the artificial teeth. Also cusp angle is directly related to muscle activity. Muscle kinetics or activity is usually tested by electromyography. Electromyography values are influenced by the type of occlusal schemes used.^{10,11}

Chewing efficiency was demonstrated by biting force, the higher the results, the better chewing efficiency was assumed. Using a load sensor the patients were asked to bite on the sensor, to measure their biting force.¹⁰ Another method of evaluating chewing efficiency was indicated by chewing of food material then spitting in a sieve and monitored with InSpec software.¹²

Patient satisfaction is becoming more one of the primary perquisites and goals when dealing with patients. One of the simplest ways of measuring patients' satisfaction is the Visual Analogue Scale (VAS) and has shown to be valid and reliable.¹³

All of the previous information brings us to several questions. Is the type of occlusion scheme used directly related to the chewing efficiency, the muscle kinetics and patient satisfaction? And what is considered optimum, to make high or low muscle contraction to cut down food?

Subjects and Methods

Ethical consideration

The protocol and consent were approved by IRB/ECs (Institutional review board/ethical committees) with respect to scientific content, compliance with applicable research and human subjects regulations.

Procedure

Twenty completely edentulous patients were selected according to following criteria

Inclusion criteria:

- 1- Completely edentulous upper and lower arches
- 2-Angle's class I for arch relationship
- 3- Good muscle and nervous coordination
- 4- Male Patients

Exclusion criteria:

- 1- Inadequate neuromuscular coordination
- 2- Patients with TMJ disorder

Preliminary impression was taken with alginate ZHERMAC, and final impression was taken with silicon impression material ZHERMAC, and poured with hard dental stone ZHERMAC to master cast. Occlusion blocks were fabricated, spring face bow WHIP MIX record was taken in group A transferred to semi adjustable HANAU™ WIDE-VUE - WHIP

MIX articulator then centric relation was recorded and mounting was done. Then protrusive record was taken from the patients, occlusion blocks returned to articulator to adjust horizontal condylar angle, from the condylar angle using HANAU formula $L = H/8 + 12$ lateral condylar angle was measured. Arranging of anatomic teeth with cusp angulation 30° , to comply with the condylar angle of all patients, try in and then processing was done. This was the first denture fabricated with a balanced occlusion (Group A). The master cast was duplicated and a second denture was fabricated with group function occlusion (Group B). A rubber index was taken of the polished surface of balanced occlusion denture (Group A) to help in waxing up of the group function occlusion (Group B). At the end of this process we had two dentures, first denture with balanced occlusion (Group A) and second denture with group function occlusion (Group B).

Patients were given the first denture for one month, and then they were recalled for the chewing efficiency and muscle kinetics tests.

For chewing efficiency patients were given Standardized Chewing Test Units (SCT) from BREDENT. The SCT are prefabricated rounded, standardize sized jelly testing units. It comes in three colored consistencies, of soft, medium, and hard. Imitating natural food consistencies, with green is soft, yellow is medium and red is hard. Chewing efficiency is tested by the ability of patient to cut the rounded unit into pieces, the more the number of pieces the better the efficiency. Patients were first given first the soft unit, chewing was started for ten complete cycles; chewing cycle was indicated by the Electromyography (EMG) test. EMG is a method of several methods in recording chewing cycles.^{14, 15} The same procedure was done for the medium and hard units Fig. 1. During the same procedure EMG was also used as a measuring tool for muscle kinetics.

Dentures of Group A were collected from the patients and then patients were given a wash out period of one week for tissue recovery before dentures of Group B were given for one month. After one month the same testing process for chewing efficiency and muscle kinetics were done.

Patient satisfaction was left at the end after the patients have experienced both groups. On a scale of 10 with 10 most satisfied and 0 not satisfied, questions were asked to the patients to test their satisfaction for both groups. Data were collected, tabulated, and statically analyzed using One-way ANOVA.

Results

1- Chewing efficiency test

Group A showed significant difference when compared with Group B means, in testing chewing efficiency for both groups. For Group A, the balanced occlusion, the soft consistency was $3.85 \pm .36$, medium consistency $5.85 \pm .65$, and hard consistency $8 \pm .55$. For Group B the group function, the soft consistency was $1.85 \pm .36$, the medium consistency $3.85 \pm .36$, and the hard consistency $5.85 \pm .65$. The difference between the three consistencies in the two group was statically significant $P < 0.01$ Table 1.

2- Electromyography test

EMG tests of the masseter muscle showed that the muscle kinetic was less in the balanced occlusion than unbalanced occlusion. The mean values for the balanced occlusion was 258.85 ± 26 and the group function occlusion was 302.28 ± 25 . Statistically there was significant difference between groups $P < 0.01$ Table 2.

3- Correlative analysis between chewing efficiency and muscle kinetics

In Group A there was a negative correlation of -0.594 on Pearson's correlation.

However in Group B, there was a positive correlation of 0.463 on Pearson's correlation. Statistically there was significant difference between means of groups with $P < 0.01$.

4- Patients' satisfaction

VAS (Visual Analogue System) was used, on a scale of 10, with (1-2) highly unsatisfied, (3-4) satisfied, (5-6) Neutral, (7-8) satisfied, and (9-10) highly satisfied. Patients were asked to evaluate their experience with both dentures after one month of usage Fig 2.

In Group A the mean was 9, which mean that the patients were highly satisfied with balanced occlusion. In Group B the mean was 5, which means patients were neutral with the group function occlusion. Statistically there was significant difference between means of groups with $P < 0.01$.

Discussion

For the chewing efficiency in Group A and group B, there was a statistically significant difference between the three consistencies within each group. In the hard consistency it was cut into more pieces than in the soft and medium consistencies, this can be attributed that, there's a better control of the teeth on hard structures, can be manipulated easier, so can be chewed better. The medium and soft are gummier so it's difficult to manipulate, so less control by the teeth and less cutting.

Between the two groups there was a statistically significant difference between all three consistencies, this can be attributed directly to the type of occlusion used. In

balanced occlusion there's even contact between teeth, which leads to better stability of the denture, thus better control of chewing units and better chewing efficiency. The number of pieces was higher in the balanced occlusion group (Group A) when compared with group function group (Group B).

Other studies described chewing efficiency by the size of the particles, the smaller the size the better chewing efficiency¹². In our study the number of particles can be related to the size of the particles, they are inversely proportion to each other, as the number of the particles increased, the size of the particles decreased Fig 1.

For EMG measures, there was a significant difference between the two groups. Group A showed lower values when compared with group B; this can be due to the fact that in balanced occlusion teeth are set up according to the physiologic position of the condyles and supporting structures. When teeth are in harmony with the supporting structures so, this lead to less effort and contraction of the muscles during the masticatory process. This result agrees with another study which has shown that altering occlusal balance significantly reduces the EMG values when compared with group function or canine guided occlusion.¹⁵ However, the EMG values of Nada et al. who used also the SCT units were lower than our research, this can be attributed to their study in which implant supported over-dentures was under examination so better retention and stability in the prosthesis than complete denture in our case.¹⁶

Table 1: Mean value, standard deviation and P values for the three consistencies in the two groups

Groups	Soft		Medium		Hard		P Value
	Mean	SD	Mean	SD	Mean	SD	
Group A	3.85	.36	5.85	.65	8	.55	P<0.01*
Group B	1.85	.36	3.85	.36	5.85	.65	P<0.01*
Group A Vs Group B	P<0.01*		P<0.01*		P<0.01*		

*SD: Standard deviation, CV: Coefficient of variance, P: Probability level, *: Significance*

Table 2: Mean value, standard deviation and P values for the EMG in the two groups

Groups	EMG μ V	
	Mean	SD
Group A	258.85	26
Group B	302.28	25
Group A Vs Group B	P<0.01*	

*SD: Standard deviation, P: Probability level, *: Significance*



Figure 1: showing pattern of cutting in both groups using the three consistencies of SCT in which G:A stands for Group A and G:B stands for Group B



Figure 2: Mean values of patients' satisfaction on a scale of 10

Within each group, when the two outcomes, chewing efficiency and Muscle kinetics, were correlated, in reverse to the hypotheses there was a correlation between the chewing efficiency and muscle kinetics in both groups. Group A showed negative correlation, this means that as the chewing consistency increased demonstrated by the number of pieces cut, the values of muscle kinetics on the EMG decreased and vice versa. This can be attributed that the occlusion is harmonious in position to the condyle and the supporting muscles. Less effort is required by the muscles to achieve more chewing efficiency. In group B, there was a positive correlation; this means that as the chewing efficiency increased, the muscles kinetics increased. This indicates that more muscle effort is required to attain better chewing efficiency.¹⁶

In Patients' satisfaction, there was a statistically significant difference between groups. Group A showed higher satisfaction values than group B, this can be accredited to the harmonious position of occlusion to supporting structures, less effort on the muscles and better cutting of units. One of the patients clearly stated "I feel more comfortable and I can chew better." This result agrees with another study, in which it was indicated that the patients scored higher

pain on the VAS scale in the group function than the balanced occlusion.¹⁷

Conclusion

It can be concluded from this study that the balanced occlusion scheme allowed better chewing efficiency, with lower muscle kinetics, and higher patients' satisfaction. Although the procedure of fabrication of balanced occlusion is more complicated than group function occlusion, but to have a better quality of life it's worth it.

Conflict of Interest:

The authors declare no conflict of interest.

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