COLORIMETRIC COMPARATIVE ANALYSIS OF MASTICATORY EFFEICIENCY IN COMPLETE DENTURE WEARERS WITH TWO DIFFERENT OCCLUSAL CONCEPTS

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ABSTRACT

INTRODUCTION: The appropriate masticatory function is of major importance in complete denture wearers, since it influences the digestion of food and quality of life. Thus, the bilateral balanced occlusal concept is used to achieve greater masticatory efficiency. However, a critical review of the literature reveals that there is not sufficient scientific evidence to support bilateral balanced occlusion as the most appropriate occlusal concept in complete dentures.

OBJECTIVES: The aim of this study was to compare clinically between complete denture wearers with bilateral balanced occlusion and canine guidance concepts through the evaluation of masticatory efficiency and patient satisfaction.

MATERIALS & METHODS: A controlled crossover clinical trial was conducted. The sample was composed by 20 edentulous patients who wore sets of complete dentures with both occlusal concepts periods of one month. Objective data were collected through the masticatory efficiency test performed by the colorimetric method with the beads, in which capsules of a synthetic material enclosing FDA approved dye-containing granules were used. Subjective data were recorded by general satisfaction patient questionnaire.

RESULTS: No significant statistical difference was found for the masticatory efficiency and patient satisfaction between the two occlusal concepts studied.

CONCLUSIONS: Both bilateral balanced occlusion and canine guidance improved the masticatory efficiency in complete denture wearers.

KEYWORDS: Bilateral balanced occlusions, canine guidance occlusion, complete dentures, masticatory efficiency, patient satisfaction.

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INTRODUCTION

The broad objectives in complete denture (CD) treatment are to provide adequate masticating function, to restore natural appearance and normal speech. These objectives are to be accomplished in a way that ensures patient comfort and preserve the integrity of the structure that support the prosthesis (1). The appropriate masticatory function is of major importance in complete denture wearers, since it influences the digestion of food and quality of life. Thus the preparation of food bolus with a natural reduction in the secretion of gastric juice with aging deserves a special attention in edentulous patients due to limitations of conventional denture. It was reported that the masticatory efficiency of complete denture wearers is only 16% to 50% that of dentate patients (2). The role of occlusion is considered by many practitioners to be the single most important factor in dentistry. That is why static and dynamic occlusions are important criteria for the success of complete denture treatment (3). The bilateral balanced occlusion (BBO) is considered by many authors as fundamental for the treatment success, as it is able to provide a greater retention and stability than the canine guidance occlusion (CGO). A better masticatory function is attributed to the BBO, since it brings more grinding surfaces in contact at each movement (4). However, reviewing the literature reveals that there is not sufficient scientific evidence to support that the BBO is the ideal occlusal concept (OC) for complete denture. Evidence suggests that the OC has a little influence on clinical outcomes and patients' satisfaction (5, 6). Furthermore, procedures involved in the construction of a set of dentures with BBO are much more complex and time consuming than those for CGO for both the dentist and the dental technician.

Further studies are necessary to investigate the advantages of BBO over CGO. Thus, the aim of this study was to evaluate the masticatory efficiency of complete denture patients with BBO and CGO.

MATERIALS AND METHODS

Following the institutional ethical acceptance, a randomized crossover clinical trial was conducted at the Clinic of Prosthodontic department, Faculty of Dentistry, Alexandria University. Completely edentulous patients visiting the Clinic of Prosthodontics and requiring new conventional CD were invited to participate in this clinical trial. After a preliminary examination, patients were excluded if they exhibited symptoms of oral disease or systematic disorders that could influence their response to treatment. The sample was composed of 20 completely edentulous patients with mean age of 47 years. All patients had previous complete denture (CD) wearing experience. Complete dentures were fabricated in accordance with the conventional techniques for each patient. Following giving informed consent, patients were randomized to one of two occlusion treatment concepts forming two groups. Group (I) included ten patients who started by BBO for one month then were converted to CGO for another month, while group (II) included the remaining ten patients who started by CGO for one month then were converted to the other concept for more one month.

Evaluation data were collected by the masticatory efficiency test and patient satisfaction questionnaires at three follow-up periods (after one month of using the first occlusal concept, another month after changing the occlusal concept and finally after the following two months of using the final changed concept) cross over design.

Denture insertion was done with verifying each occlusion concept to be the same as it was created on the same articulator (Whip MIX Articulator model 8500,U.S).The change from BBO to CGO of all dentures was performed clinically by the same dentist through the addition of a light-cured composite resin in the lower canines (figures 1).

Figure (1): Addition of a light-cured composite resin in the lower canines

This addition was done in such a way that it could provide an interarch disocclusion space of 2 mm in the molar region during eccentric movements (figure 2).

The correct color of the composite that matches the artificial denture teeth was chosen. The composite resin (Valux TM Plus; 3M / ESPE, Germany) was applied into the mechanical undercut holes and the resin was light-cured for 40 seconds. After the resin polymerization, the occlusal adjustment was done.

Objective evaluation of masticatory function was performed through a colorimetric technique (8). Prepared beads were used to be as the artificial test-food used to measure masticatory efficiency. The beads were prepared by ionotropic jellification of an aqueous dispersion of 2%w/w pectin containing 50% solids and a FDA approved red dye of 0.2 % w/w concentration (Table 1).

Figure (2): An interarch disocclusion space of 2 mm in the molar region durin eccentric movements**.**

In group (II), this change was started at the day of denture insertion, while in group (I) it was done after one month. To change from CGO to BBO, the composite resin was removed and the BBO occlusion was verified. The technique applied to bond the composite to the acrylic resin teeth was the same described by Vergani et al (7). Mechanical undercut holes were placed in the lower canines with an inverted cone carbide bur and the incised surface of the teeth was treated with chloroform for 5 seconds. Then, the teeth were rinsed with water for 20 seconds. A thin layer of an adhesive (Single bond universal; 3M/ESPE, Germany) was brushed into the mechanical undercut holes and over the incised surfaces. The layer was cured for 20 seconds with a visible light source

Table (1): The composition of the beads and the coating materials**.**

Rx	**Weight in grams**
Lactose	20.00
Corn starch	15.00
Sucrose	15.00
Pectin	2.00
FD & C dye No.40	0.20
Distilled water	47.80
Total weight	100
Coat components: Eudragit E100 Acetone	50 ml

The powdered ingredients were mixed by a geometric addition technique in a mortar for 5 min. The aqueous dispersion of pectin was added gradually until a smooth paste was obtained. The paste was granulated in Erweka Wet Granulator (Germany) to produce wet granules. The granules were spread in trays and dried in an oven for 8 hours. Then the granules were coated by spraying acetone solution of Eudragit (E100) on the beads with gentle mixing with a spatula. The coated beads were left to evaporate the solvent at room temperature for 6 hours. Then, 250 mg of the coated beads were packed in 13mm long gelatin capsules with 0.9 mm thick walls, inner diameter of 7.00 mm and outer diameter of 8.00 mm. The capsules were sealed by welding to prevent the entrance of their content into the oral cavity (Fig.3).

Figure (3): Tested colored beads

The subjects were seated on a chair with a back and their both feet were resting on the ground. They were instructed to chew the beads in their habitual manner for 20 s then the capsules were collected into a container identified by subject and test number. After mastication , the contents of the capsule were mixed constantly for 30 s with 5 mL of distilled water. The solution was then filtered through a qualitative filter paper and the extracted dye was quantified in nanometers (nm) with a spectrophotometer (UV-Visible Helios α spectrophotometer, Thermospectronic, UK). It allowed the measurement of the masticatory efficiency on the basis of the concentration of extracted dye, expressed in absorbance (abs) at the maximum wavelength of 310 nm. The preparation and analysis of the beads were carried out at the Central Laboratory of the Faculty of Pharmacy, Alexandria University.

A method for quantifying the overall satisfaction of CD wearers was used (9). Patients were asked to respond to questions with three-grade answers (well satisfied, satisfied, and dissatisfied) concerning 8 factors: esthetics, retention, stability, comfort, speech, tasting, pain and chewing efficiency. Then, the three grades were turned into scores (2, 1, 0), respectively according to the degree of contribution of each factor as previously established.

The primary outcome measure selected for this evaluation was the masticatory efficiency. Absorbance values and Patient satisfaction were compared between occlusal concepts using the F test (ANOVA). A significance level of 5% was set for all analyses.

RESULTS

There was statistical significant increase of the dye concentration for patients of group I at the first follow-up period (one month of denture use) when compared with patients of group II (p=0.015) (table 2).

Table (2): Comparison of the dye concentration (ug /ml ± SD) between group (I) and (II) after 1 month of using the first occlusal concept.

	The mean concentration of the dye in (ug /ml) for		t	p
	Group I (n=10)	Group II (n=10)		
Min. – Max.	3.674– 6.85	0.74 – 7.04		
Mean ± SD.	4.98 ± 1.14	3.30 ± 1.60	2.703*	0.015*
Median	4.70	2.97		

Group I: After 1 month use BBO
Group II: After 1 month use CGO
*: Statistically significant at $p \leq 0.05$

After changing the first used occlusal concept and using dentures for other month (second follow up period) there was no significant difference between concentration of the dye for both groups (p=0.282) (table3).

At the third follow-up period (two months of using the last changed occlusal concept)) the same non statistical significant results were found between the two occlusion concept groups (p=0.22) (Table 4) (figure 4).

There was no statistical significant difference between patient satisfaction scores for all patients of both groups at all the follow up periods inspite of the higher values of the mean patient satisfaction scores for CGO concept (figure 5).

Table 3): Comparison of dye concentration (ug /ml) between groups (I) and (II) after 1 month of using the second (changed) occlusal concept

	The mean concentration of the dye in (ug /ml) for		t	p
	Group I (n=10)	Group II (n=10)		
Min. – Max.	3.73 – 10.53	2.623 – 9.373		
Mean ± SD.	5.80 ± 2.63	4.46 ± 2.28	1.116	0.282
Median	4.53	3.82		

Group I: After 1 month use CGO
Group II: After 1 month use BBO
Statistically significant at $p \leq 0.05$

Table (4): Comparison of dye concentration (ug /ml) between groups (I) and (II) after 2 months of using the final changed occlusal concept

	The mean concentration of the dye in (ug /ml) for		t	p
	Group I (n=10)	Group II (n=10)		
Min. – Max.	3.77 – 12.46	0.74 – 9.37		
Mean ± SD.	6.49 ± 2.97	5.10± 2.68	1.270	0.220
Median	5.10	4.21		

Group I: After 2 Months use CGO
Group II: After 2 Months use BBO
Statistically significant at $p \leq 0.05$

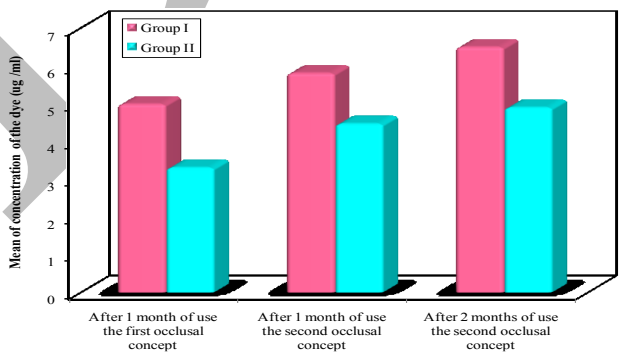

Figure (4): Comparison of mean dye concentration (ug /mL) between groups I and II at the different follow-up periods

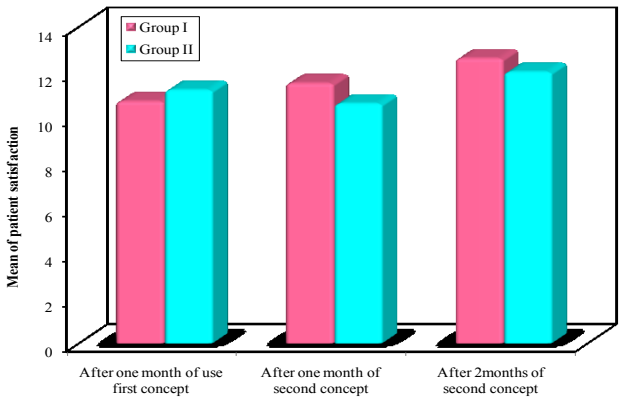

Figure (5): Comparison between groups I and II at the different follow up periods according to patient satisfaction

The results of this study revealed that:

- No statistical significant difference was manifested between the studied occlusal concepts (BBO and CGO) during the different follow up periods as regard to masticatory efficiency using mean concentration of the test dye.
- There were increase in masticatory efficiency during the different follow up periods with more improvement at the end of the study regardless of the type of occlusal scheme used declaring that the patient adaptation to denture by time is more effective as regard masticatory efficiency.
- More improvement in patient satisfaction at all follow up periods with statistical significant values were found at the end of the study with both concepts.
- No statistical significant difference was found when comparing the first two follow up periods as regard to patient satisfaction.
- The higher scores of patient satisfaction were found with CGO concept at all follow up periods.

DISCUSSION

The crossover design which was used for this study is common on human research in medicine and dentistry and has been used successfully in other trials that investigated occlusal concepts in complete dentures (10, 11). This design has major advantage which is the elimination of inter-subject response variation to the same treatment, since all treatments are applied to all subjects thus increasing the statistical efficiency of the study giving the need for a smaller number of subjects (2).A sample size of twenty patients was derived from a previously published crossover trials. Furthermore, since each patient works as his/her own control, the crossover design allows the reduction of the effect of non-controlled external variables, such as sex, previous denture experience, mucosal health status and resiliency, and alveolar ridge height and width (11). On the other hand, a problem with crossover trials is the carry-over effect. While a washout period is necessary in pharmacological trials, carry-over effects are unlikely in oral rehabilitation. Therefore, a washout period was not included. Additionally, leaving patients without a denture for a washout period was not considered possible for ethical reasons (2, 11).

Unlike previous studies that investigated masticatory function in complete dentures by conventional investigation (12, 13), our study measured the masticatory efficiency using colored beads as the test material which is promptly evaluated and has stable physical properties. Since the beads are packed in capsules, the material is fully obtained from the mouth, with no danger of being swallowed or dissolved by saliva. Laboratory processing is fast and effective and allows determining exactly the patient's masticatory efficiency. The capsules are not torn nor ripped during mastication, and thus the granules are kept inside the capsule (14).

BBO and CGO were chosen to be evaluated in this study since both include simultaneous contact in centric occlusion, but in eccentric movements they differ. BBO is the basis of all lateral occlusal concepts (15), which attempts to balance the denture teeth in laterotrusive and protrusive movements. Some studies suggested that there was evidence that the balance of teeth is the physiologic necessity and recommended BBO (16). CGO, on the other hand, disengages the posterior teeth in the excursive movements of the mandible by vertical and horizontal overlap of the canines (10). Other studies recommended and preferred this scheme for complete denture wearers (11, 17).

Canine guidance establishment can be performed by many ways. Adding composite resin to the canines to disengage the posterior teeth which was performed in our study is the easier technique. It used the same teeth and saved time to establish and adjust canine guided dentures (10).

The opinion that the BBO promotes better masticatory efficiency by bringing a larger amount of grinding surfaces into contact at each movement was approved by many investigators (13,
18). But our results did not reveal any significant difference for the masticatory efficiency (chewing strength) between the studied occlusal concepts (BBO and CGO). This finding coincides with those of Neto AF et al (2), who stated that BBO does not improve the masticatory efficiency in complete denture wearers. The results of our study showed a significant difference for the masticatory efficiency with higher mean scores of dye concentrations for group I who started with BBO concept than group II who started with CGO concept at the first follow up period. This finding can be attributed to that BBO facilitates the adaptation of a new denture as reported by Rehmann et al (19), who found that BBO enhanced patient adaptation in the early phase of denture insertion. They also supposed that BBO minimizes rocking movements during protrusion and consequently, produces a fewer neuronal stimuli compared with CGO. Once adaptation occurred, no significant difference was found between the masticatory efficiency of the two studied groups at the following two follow up periods. In this study, no relationship was found between masticatory efficiency and the type of occlusal concept. Besides, there was no statistical significant difference for patient overall satisfaction.

There was no clinical evidence to support BBO as the ideal occlusal concept for complete denture wearers. Dentures with CGO were expected to impair masticatory function because the highest incidence of oblique forces capable of dislodging the denture and thus causing traumatic ulcers on oral mucosa during mastication (2).However, our study did not express that expectation. Thus, it was supposed that CGO did not decrease retention and stability besides that balancing contacts are not found during mastication and probably are not physiologically necessary. With the food bolus between the teeth, the occlusal surfaces do not make contact with each other, but with the food (2). It was obvious from our research that the CGO seems to be a viable approach because it is easier to be achieved by dentists and dental technicians and does not compromise function and satisfaction.

Additional randomized controlled clinical trials are required to be developed taking into account the influence of gender, mucosal resiliency and alveolar ridge height on the masticatory efficiency and its importance on occlusal concept choice.

CONCLUSIONS

With the limitation in our study of short follow up periods of denture use we conclude that canine guidance occlusal concept can be used successfully in construction of

complete dentures without affection of masticatory efficiency, and also with enhancing patient general satisfaction. The results of the study lead to the following conclusions:

- Both BBO and CGO improve the masticatory efficiency for complete denture wearers without obvious significant difference between them.
- CGO improves general patient satisfaction as denture expresses good esthetics, chewing ability and comfort ability.
- Procedures involved in construction of dentures with CGO are simpler and less time consuming than those for BBO for both dentist and dental technician.
- Evaluation of the masticatory efficiency using nanometer by spectrophotometer measuring the chewing strength of each patient using capsulated test beads can be considered as a precise evaluation method.

CONFLICT OF INTEREST

"The authors declare that they have no conflicts of interest".

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