EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
VOL. 68, 1613:1621, APRIL, 2022
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
FIXED PROSTHODONTICS AND DENTAL MATERIALS
Submit Date : 2022-01-29 • Accept Date : 2022-03-29 • Available online: 2022-03-30 • DOI : 10.21608/edj.2022.116464.1951

# RANDOMIZED CONTROLLED STUDY COMPARING BILATERAL BALANCED AND LINGUALIZED OCCLUSION CONCEPTS FOR IMPLANT ASSISTED MANDIBULAR OVERDENTURES

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## *ABSTRACT*

**Background:** Occlusal scheme configuration is a key factor in implant prosthodontics success. However, the choice of occlusal scheme for implant assisted prosthesis is broad and controversial. The aim of the present study was to evaluate the effect of two different occlusal concepts on the masticatory muscles activity of completely edentulous patients rehabilitated with implant assisted mandibular overdentures lined with resilient liners.

**Methods:** Twenty completely edentulous male patients with age group of 50-60 years were included. Patients were divided randomly and equally into two groups. Group-I patients received two implant assisted mandibular overdenture and maxillary complete denture with Bilateral Balanced Occlusion (BBO) using semi-anatomic teeth. Group-II patients received two implant assisted mandibular overdenture and maxillary complete denture with Lingualized Occlusion (LO) using semi-anatomic-ortho-lingual teeth. Masseter and Temporalis muscle activities were evaluated using surface Electromyography (sEMG) at insertion, three, six and 12 months of follow-up period.

**Results:** The cumulative implant success rate at the end of follow-up period was 100%. There were no statistical significant differences along the time intervals ($P \geq 0.05$) between both groups; however, Group (II) patients revealed improved masticatory muscle activity than that with Group (I) patients.

**Conclusions:** Electromyographic activities of the masseter and temporalis muscles improved in both groups. Lingualized Occlusal scheme coupled with resilient denture liners used for implant assisted overdentures improved the masticatory muscle activity providing better masticatory efficiency and patient comfort.

**KEYWORDS:** Implant assisted overdentures, Occlusion, Resilient denture liners, Surface Electromyography, Masticatory muscles activity.

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## INTRODUCTION

Several retrospective and prospective studies concluded that implant-retained overdentures represent a valid beneficial option for complete denture wearers, providing predictable improvement over conventional prosthodontics with relative simplicity and significant longer-term prosthetic rehabilitation [1].

Alveolar bone loss reduces the size of the denture bearing area, resulting in decreased denture stability, insufficient lower denture retention, difficulty eating and speaking, and altered facial appearance. These issues present a significant challenge for clinicians attempting to provide a satisfactory solution for their patients' oral health problems [2].

Implant retained Overdentures provide improved stability, retention, chewing function, appearance, patient satisfaction, and quality of life. Furthermore, implants reduce further bone resorption with long-term success rates and minimal complications [3].

Resilient denture liners are becoming increasingly popular in a variety of applications in prosthetic dentistry. Their inherent elastic and viscoelastic properties improves patient comfort, speech, chewing ability, denture retention and stability, and it also reduces pain or soreness under the denture, allowing for longer denture wearing times [4, 5].

The occlusal scheme is critical to the success of implant prosthodontics. If occlusal forces are not properly controlled, bone loss, prosthesis fracture, or implant failure may result [6].

Bilateral Balanced Occlusion has been advocated for patients rehabilitated with implant-retained overdentures as opposed to maxillary complete dentures in order to improve denture stability, reduce trauma to the underlying tissues, improve masticatory efficiency, and distribute masticatory forces over the supporting structures. However, many researchers regarded the lingualized concept of occlusion as the preferred occlusal scheme for patients rehabilitated with implant-retained prostheses [7].

Lingualized occlusion provides esthetics, chewing efficiency and mechanical occlusal freedom while negating many of the disadvantages of other occlusal schemes that might be considered for a specific situation [8].

Given the evidence for masticatory muscle behavior, Electromyographic evaluation appears to be an important diagnostic modality used in the assessment of Stomatognathic system function, including neuromuscular pathology or pain-related temporomandibular disorders, in which muscle hyperactivity has been implicated as the main etiologic factor [9].

Surface Electromyography for masticatory muscles provides functional quantitative analyses for bilateral muscles contraction symmetry, maximum muscle activation as well as frequency spectrum in resting conditions [10].

Specific occlusal design evidence for implant assisted overdenture is disputable Therefore, the study was conducted to assess the effect of two distinct occlusal schemes on masticatory muscles activity of completely edentulous patients rehabilitated with implant assisted mandibular overdentures lined with resilient denture liner to test the null hypothesis that occlusal designs can significantly affect masticatory muscles behavior.

## MATERIALS AND METHODS

Twenty fully edentulous males (ages between 50 and 60) were chosen from those attending the Outpatient clinic, Removable Prosthodontics Department, Faculty of Dentistry, British University in Egypt, to participate in the study.

Detailed medical history was taken for all participants in order to assess their overall health and ensure that they were free of any systemic diseases that could affect implant osseointegration or neurologic disorders that could affect the neuromuscular system.

For all candidates, laboratory investigations were made, smokers and those with inadequate oral hygiene or Glycosylated Hemoglobin levels (HbA1c) above 7.5% were excluded.

Participants with firm healthy basal seat mucosa, adequate inter-arch space and Angle's class I maxillary-mandibular relation as verified by a diagnostic jaw relation record were enrolled.

Diagnostic panoramic radiographs were made for all candidates to assess the anterior region of the mandible and to exclude the presence of any pathology or bone abnormality.

All candidates were well informed about the goal of the investigation, the study objectives and signed an informed consent approved by the Research Ethics Committee, Faculty of Dentistry, British University in Egypt after discussing the treatment plan and before treatment initiation. The informed consent clearly stated that the subject could quit any time without loss of any benefits.

**Patient Number Selection (Power Analysis)**

The total sample size is twenty patients for the two groups using randomized clinical trial technique [11]. The significance level is 0.05, the power sample size is 86% with confidence interval of 95% and the actual power is 97.36%. GPower version 3.1 software was used for sample size analysis.

**Patient Grouping**

Patients were divided into two random equal groups. **Group I** patients received mandibular assisted overdenture with silicone-based resilient denture lining material (MucoSoft® Reline) and a maxillary complete denture with Bilateral Balanced Occlusion (BBO) using semi-anatomic teeth **(Fig.1A).** Two mandibular implants were placed anteriorly (AnyOne® two-piece internal dental implant, MEGA'GEN Implant System, Korea) and immediately loaded with Equator® attachments .

**Group II** patients received a mandibular assisted overdenture with resilient denture lining material (MucoSoft® Reline) and a maxillary complete denture with the Lingualized Occlusion (LO) using semianatomic ortho-lingual teeth **(Fig.1B)**. Two mandibular implants were placed anteriorly (AnyOne® two-piece internal dental implant, MEGA'GEN Implant System, Korea) and immediately loaded with Equator® attachments.

Conventional dentures were constructed where Semi-anatomic teeth (DENTSPLY. England) were used for cases of the Bilateral Balanced Occlusion (BBO), while semi-anatomic ortho-lingual teeth (IVOCLAR VIVADENT. Germany) were used for cases of the Lingualized Occlusion (LO), where foil spacer of 2mm thickness was adapted to the

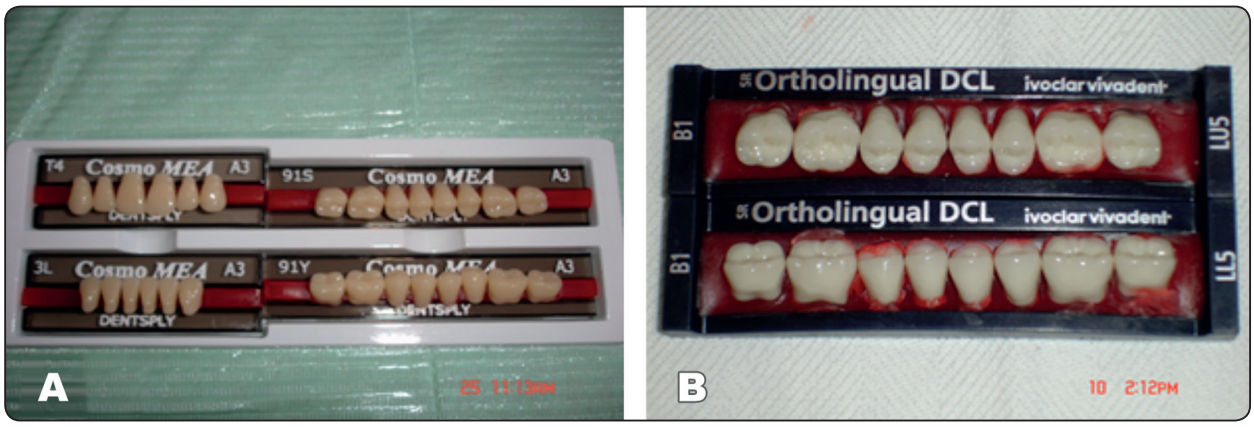


Fig. (1) A: Semianatomic teeth for the bilateral balanced occlusion concept, B: Ortho lingual semianatomic teeth for the lingualized occlusion concept.

mandibular master casts before denture processing to provide sufficient room for the resilient liner application.

For all Patients Cone Beam Computed Tomographic Radiographs were made to evaluated Bone width, height and Pixel intensity at the proposed implant sites using clear-resin denture duplicates, Then the clear duplicates were modified to provide a Non-limiting surgical templates to aid in implant insertion **(Fig.2)**

Fig. (2): Clinical picture showing the two implants inserted in the mandibular edentulous arch.

24 hours following implant insertion; patients were recalled, the Equator® attachments were directly picked-up using hard denture liner *(MucoHard™),* the spacer was removed and the resilient denture liner was applied.

Patients were instructed for hygiene measures and recalled for denture bearing area examination and to detect any signs of tissue irritation.

The Masseter and Temporalis Electromyographic records were obtained via surface electrodes (Sierra II EMG/NCV/EP) while chewing soft food, hard food and during clenching **(Fig.3)**.

The most palpable site for superficial Masseter muscle was found to be 2.5 cm above the inferior border of the mandible midway between mandibular angle and anterior muscle border. While the most palpable site for Temporalis muscle was found to be 2.5 cm posterior to the lateral margin of the orbit and above the superior border of the zygomatic arch.

Fig. (3): Attachment of surface electrodes.

**Statistical Analysis:**

Data were provided by mean and standard deviation values. Repeated measures ANOVA and t Student test were used for comparison between the studied groups where $P \leq 0.05$ was set as significance level. Statistical analysis was carried out with IBM SPSS Statistics Software Version 20 for Windows.

## RESULTS

The results of repeated-measures ANOVA analysis of EMG for the masseter and temporalis muscles at different intervals of follow-up are illustrated in Tables **(1&2)**. Both Groups revealed significant increase of EMG records for Masseter and temporalis muscles ($P < 0.001$) through the follow-up period.

The results of the t student test analysis for the comparison of EMG records for Masseter and temporalis muscle at different of follow up periods between the two groups are illustrated in Tables **(3&4)**, where non-significant difference was found between both groups.

TABLE (1): Results of the repeated-measures ANOVA of EMG of the masseter muscle at different periods of follow up.

| | | Masseter Muscle | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Zero Record (T0) | | 3 months (T3) | | 6 months (T6) | | 12 months (T12) | | P-Value |
| | | Mean | SD | Mean | SD | Mean | SD | Mean | SD | |
| **Bilateral Balanced Occlusion (Group I)** | **Clenching** | 0.47 | 0.22 | 0.53 | 0.2 | 0.55 | 0.17 | 0.58 | 0.11 | <0.001* |
| | **Soft Food** | 0.32 | 0.09 | 0.36 | 0.08 | 0.37 | 0.05 | 0.41 | 0.09 | <0.001* |
| | **Hard Food** | 0.55 | 0.09 | 0.57 | 0.07 | 0.59 | 0.16 | 0.65 | 0.06 | <0.001* |
| **Lingualized Occlusion (Group II)** | **Clenching** | 0.54 | 0.22 | 0.61 | 0.14 | 0.62 | 0.23 | 0.69 | 0.2 | <0.001* |
| | **Soft Food** | 0.37 | 0.06 | 0.38 | 0.07 | 0.4 | 0.1 | 0.43 | 0.08 | <0.001* |
| | **Hard Food** | 0.65 | 0.14 | 0.67 | 0.13 | 0.68 | 0.16 | 0.73 | 0.15 | <0.001* |

***T0: At insertion. T3: After 3 months. T6: After 6 months. T12: After 12 months.***

**** Significant, (P > 0.05).***

TABLE (2): Results of the repeated-measures ANOVA of EMG of the temporalis muscle at different periods of follow up.

| | | Temporalis Muscle | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Zero Record (T0) | | 3 months (T3) | | 6 months (T6) | | 12 months (T12) | | P-Value |
| | | Mean | SD | Mean | SD | Mean | SD | Mean | SD | |
| **Bilateral Balanced Occlusion (Group I)** | **Clenching** | 0.43 | 0.07 | 0.45 | 0.07 | 0.46 | 0.11 | 0.52 | 0.14 | <0.001* |
| | **Soft Food** | 0.32 | 0.07 | 0.37 | 0.09 | 0.39 | 0.07 | 0.43 | 0.13 | <0.001* |
| | **Hard Food** | 0.65 | 0.11 | 0.68 | 0.12 | 0.72 | 0.09 | 0.75 | 0.08 | <0.001* |
| **Lingualized Occlusion (Group II)** | **Clenching** | 0.65 | 0.18 | 0.67 | 0.15 | 0.71 | 0.09 | 0.73 | 0.08 | <0.001* |
| | **Soft Food** | 0.44 | 0.04 | 0.46 | 0.07 | 0.49 | 0.09 | 0.51 | 0.07 | <0.001* |
| | **Hard Food** | 0.68 | 0.11 | 0.72 | 0.08 | 0.74 | 0.06 | 0.77 | 0.05 | <0.001* |

***T0: At insertion. T3: After 3 months. T6: After 6 months. T12: After 12 months.***

**** Significant, (P > 0.05).***

TABLE (3): Comparison of EMG of the masseter muscle at different periods of follow up between the two groups

| Masseter Muscle | | Bilateral Balanced Occlusion (Group I) | | Lingualized Occlusion (Group II) | | T | P |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | 0.174 | 0.135 |
| Clenching | T0 | 0.47 | 0.22 | 0.54 | 0.22 | 0.326 | 0.276 |
| | T3 | 0.53 | 0.2 | 0.61 | 0.14 | 0.404 | 0.322 |
| | T6 | 0.55 | 0.17 | 0.62 | 0.23 | 0.465 | 0.029 |
| | T12 | 0.58 | 0.11 | 0.69 | 0.2 | 0.302 | 0.03 |
| Soft Food | T0 | 0.32 | 0.09 | 0.37 | 0.06 | 0.235 | 0.221 |
| | T3 | 0.36 | 0.08 | 0.38 | 0.07 | 0.426 | 0.155 |
| | T6 | 0.37 | 0.05 | 0.4 | 0.1 | 0.433 | 0.366 |
| | T12 | 0.41 | 0.09 | 0.43 | 0.08 | 0.189 | 0.452 |
| Hard Food | T0 | 0.55 | 0.09 | 0.65 | 0.14 | 0.344 | 0.033 |
| | T3 | 0.57 | 0.07 | 0.67 | 0.13 | 0.411 | 0.142 |
| | T6 | 0.59 | 0.16 | 0.68 | 0.16 | 0.468 | 0.336 |
| | T12 | 0.65 | 0.06 | 0.73 | 0.15 | 0.447 | 0.225 |

***T0: At insertion. T3: After 3 months. T6: After 6 months. T12: After 12 months. * Significant, (P > 0.05).***

TABLE (4): Comparison of EMG of the temporalis muscle at different periods of follow up between the two groups

| Temporalis Muscle | | Bilateral Balanced Occlusion (Group I) | | Lingualized Occlusion (Group II) | | T | P |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | 0.306 | 0.532 |
| Clenching | T0 | 0.43 | 0.07 | 0.65 | 0.18 | 0.444 | 0.443 |
| | T3 | 0.45 | 0.07 | 0.67 | 0.15 | 0.526 | 0.353 |
| | T6 | 0.46 | 0.11 | 0.71 | 0.09 | 0.615 | 0.542 |
| | T12 | 0.52 | 0.14 | 0.73 | 0.08 | 0.324 | 0.334 |
| Soft Food | T0 | 0.32 | 0.07 | 0.44 | 0.04 | 0.423 | 0.355 |
| | T3 | 0.37 | 0.09 | 0.46 | 0.07 | 0.445 | 0.367 |
| | T6 | 0.39 | 0.07 | 0.49 | 0.09 | 0.432 | 0.235 |
| | T12 | 0.43 | 0.13 | 0.51 | 0.07 | 0.332 | 0.543 |
| Hard Food | T0 | 0.65 | 0.11 | 0.68 | 0.11 | 0.367 | 0.358 |
| | T3 | 0.68 | 0.12 | 0.72 | 0.08 | 0.344 | 0.445 |
| | T6 | 0.72 | 0.09 | 0.74 | 0.06 | 0.656 | 0.554 |
| | T12 | 0.75 | 0.08 | 0.77 | 0.05 | 0.546 | 0.653 |

***T0: At insertion. T3: After 3 months. T6: After 6 months. T12: After 12 months. * Significant, (P > 0.05).***

## DISCUSSION

Due to bone-implant interface, occlusion is of extreme importance for implant durability. Thus if occlusal forces exceed the interface's ability to absorb stress, the implant will finally fail [12].

A crucial aspect for implant-supported prosthesis' long-term success rate is through development of occlusal design that runs in harmony with the rest of the masticatory system [13]. The role of occlusion in implant success was highlighted in several studies where post-insertion implant related complications were directly correlated to occlusal scheme configuration [14,15,16,17].

Currently, debatable evidence on which occlusal design is advocated for implant-assisted overdentures exist, however, lingualized occlusion (LO) has the potential to surpass other occlusal designs in terms of clinical outcomes as a result of reduced lateral force components [18,19]. While bilateral balanced occlusion (BBO) improves mastication process through increased occlusal contacts [20,21].

The study revealed statistically insignificant difference ($P \geq 0.05$) along time intervals between both groups; however, Group (II) patients demonstrated improved masticatory muscle activity than Group (I) patients, this may be attributed to reduced lateral forces while maintaining food penetration properties with improved patient satisfaction [18,19].

Patients rehabilitated with lingualized occlusion (particularly with poor bone conditions) demonstrated higher masticatory efficiency, improved denture stability over those treated with bilateral balanced occlusion [22].

Significant gradual increase in Electromyographic amplitudes of the masseter and temporalis muscles in both groups was noticed throughout the follow-up period. This can be explained by the fact that restoration insertion usually requires an accommodation period that varies depending on the type of restoration and patient accommodation for denture use [23].

Implant assisted dentures enables the patient to exert maximal biting force with low risk of extensive stress transfer to the supporting structures and likely less inflammation and bone resorption [24,25,26].

Following denture insertion, patients will experience neuromuscular adaption. Meanwhile, to protect oral structures and restore function, careful adjustments are necessary [27,28,29].

Resilient liners offer a wide range of uses due to their viscoelastic nature, which allow for masticatory stress distribution and alleviate mucosal pain produced by ill–fitting prosthesis [30], while providing greater comfort for edentulous patients who are experiencing eating difficulties [31,32].

For individuals with mandibular full dentures, resilient liners surpassed traditional denture base resins in terms of applying maximal occlusal forces[33]. In other words, the degree of maximum occlusal force is determined by mucosal stress tolerance and pain threshold [34], where resilient denture liners reduce the maximum stress nearly by 16.2 % when compared to conventional denture bases material[35].

The significant gradual increase in EMG activity of both muscles in two studied groups during the follow-up period could be attributed not only to the elasticity of the liner, but also to the increased pain threshold [36].

Both muscles revealed insignificant difference between the two groups or test foods, indicating that no specific food type can be recommended to differentiate between different occlusal schemes [37].

## CONCLUSIONS

Within the study limitations, the findings suggest that both lingualized and bilateral balanced occlusal schemes can be successfully used in implant-assisted overdenture fabrication.

## CONFLICT OF INTEREST

Authors declare no conflict of interests and complete control over all primary data.

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