Comparison of Monoplane Occlusion and Median Lingualized Occlusion in Implant-Retained Mandibular Complete Overdenture

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Abstract

Purpose: To compare median lingualized and monoplane occlusion in implant retained mandibular overdenture with ball and socket attachment.

Materials and Methods: Ten completely edentulous patients were selected to receive with dental implants. Each patient received two cylinders with reversed screw and hydroxyapatite coated dental implants, one implant on each side in the canine regions of the mandible. The implants were left submerged (unloaded) for a healing and osseointegration period of four months. The patients were divided into two groups, five patients in each. Group I patients received overdenture retained by ball and socket attachment, the artificial teeth were arranged in a median lingualized occlusion, and Group II patients received overdenture retained by ball and socket attachment but the artificial teeth were arranged in a monoplane occlusion. All patients were evaluated clinically and radiographically immediately after overdenture delivery and after 6 and 12 months.

Results and conclusion: There was no statistically significant difference between median lingualized and monoplane occlusion in implants supporting a mandibular overdenture retained by ball and socket attachment. From the clinical point of view, satisfactory results were obtained when two dental implants were placed in the intraforaminal region of the mandible and connected with ball and socket attachment to support and retain mandibular overdenture. These satisfactory results were obtained with median lingualized occlusion as well as with monoplane ones.

Keywords: Dental Implant; Median Lingualized Occlusion; Monoplane Occlusion; Ball & Socket Attachment; Overdenture

Introduction

The stability and retention of complete dentures can be compromised by displacing forces, which are created during mastication, swallowing, and parafunctional habits. Throughout these functions, the maxillary and mandibular teeth come into contact, and unfavorable displacing forces can overwhelm the retention and stability of the dentures, creating discomfort from trauma to the underlying mucosa [1].

If the fitting and polished surfaces are ideal, it is assumed that the form of the occlusal surfaces and the nature of their contacts become critical for successful denture function. The search for the most appropriate occlusal form and tooth arrangement for complete denture occlusion has been ongoing for almost two centuries [2].

Occlusal overload is often regarded as one of the main causes for peri-implant bone loss and implant/prosthesis failure. Studies have suggested that occlusal overload may contribute to implant bone loss and/or loss of osseointegration of successfully integrated implants [3-5].

The causality of occlusal overloading for peri-implant tissue loss is questionable due to insufficient scientific evidences. However, it needs to be stressed that occlusal overload can cause mechanical complications on dental implants and implant prostheses such as screw loosening and/or fracture, prosthesis fracture, and implant fracture, eventually leading to compromised implant longevity [6].

Materials and Methods

Ten completely edentulous patients with age ranged from 50-68 years were selected. The patients were free from any systemic or local disease that contraindicate the placement of the dental implants, each patient received two stages octa titanium implants with 3.75 mm diameter and 14 mm length. The implant was cylinder with reversed screw and hydroxyapatite coat.

The implants were left submerged unloaded for a healing and osseointegration period of 4 months. The implants were then uncovered and the screw was replaced with the healing abutment.

Patients sharing in this study were randomly divided into two equal groups:

Group A: Implant retained mandibular overdenture with ball and socket attachment and the artificial teeth were arranged in a median lingualized occlusion.

Group B: Implant retained mandibular overdenture with ball and socket attachment and the artificial teeth were arranged in a monoplane occlusion.

New denture was constructed according to:

1. The median lingualized occlusion:
   The anterior teeth were arranged with sufficient vertical overlap for esthetic and phonetic demands and adequate horizontal overlap was allowed to avoid interference in lateral and protrusive movements. The buccal cusps of the maxillary posterior teeth were reduced 1mm to eliminate buccal cusp contact in both centric and eccentric jaw positions.

   The upper posterior teeth were arranged with their palatal cusps occluding in the modified central fossae of the lower posterior teeth.

2. The monoplane occlusion:
   Zero degree posterior teeth were used for monoplane occlusion. The upper and lower anterior teeth were arranged without any horizontal or vertical overlap. The posterior teeth were arranged in a horizontal plane antero-posteriorly and medio-laterally. The occlusal plane should evenly divide the space between the upper and lower ridges, paralleling the mean foundation plane and ended at the junction of the upper and middle thirds of the retromolar pad. The rubber O-rings were incorporated into the ball abutments for implant retained mandibular overdenture with ball and socket attachment.
All patients were evaluated clinically and radiographically immediately after overdenture delivery and after 6, and 12 months.

**Clinical Evaluation**

**Mobility Test (MT):** The supragingival of each implant was subjected to alternative pressure in different directions.

**Percussion (P):** The abutments were subjected to percussion by handles of dental mirrors and the sound was recorded [7,8]. The following index was used:

- Score 0 - high percussion sound
- Score 1 - dull percussion sound, indicating mobility of the implant

**Gingival Index (GI):** The gingival index score of each implant was recorded on surfaces (mesially, distally, buccally and lingually) according to Loe, Silness, the mean value of the right and left implants were added and the mean was calculated [9].

**Plaque Index (PI):** Plaque index: According to Mombelli et al [10], the plaque index scores were obtained from collecting the affected surfaces of the abutments.

**Probing Depth (Depth of the gingival sulcus):** The gingival sulcus depth was measured around each abutment using a graduated sensor periodontal probe on the middle of the four surfaces; buccal, lingual, mesial and distal regions. The mean of the four readings was considered as the pocket depth of that abutment. The mean values of the pocket depth of the two implants (right and left) were considered as the average of pocket depth.

**Radiographic Evaluation**

**Marginal Bone Height:** The radiographic evaluation included measuring the marginal bone height and bone density. Panoramic radiographs and standardized long cone paralleling technique with radiographic template were used to obtain serial periapical radiographs for each implant for measuring mesial and distal marginal bone height, and bone density.

**Statistical analysis**

Data analysis was performed with one way analysis of variance (ANOVA) and t-test as function of follow up period. Statistical analysis was performed using the software Graphpad Prism-4 statistics for Windows.

P values less than 0.05 are considered to be statistically significant in all tests.

**Results**

All patients attended all the follow-up recalls till the end of the study (12 months).

1. Evaluation of the prostheses and patients’ satisfaction: During the follow-up period, all patients were satisfied with their prostheses, regarding denture stability, retention, esthetics, occlusion and efficiency.

2. Results of implant mobility: No movement was detected in the implants under clinical testing throughout the whole follow up period.

3. Results of percussion: Percussion on implants of both groups, at all intervals of the follow-up period revealed score 0 = high percussion sound, indicating direct contact between bone and implants i.e., successful osseointegration.

4. Gingival index change: Comparison of the mean changes of gingival index from the baseline values for the MLO versus the MPO group showed no significant differences at the different intervals of the follow-up period (p > 0.05) (Table 1).

5. Plaque index change: Statistical analysis of the mean percentage change in plaque index from the BL for MLO and MPO group revealed a non-significant difference from BL to six month period (p > 0.05) and a significant difference from BL to 12 month period (p < 0.05). Comparison of the mean changes of plaque index from the BL values for the MLO versus the MPO group showed no significant differences at the different intervals of the follow-up period (p > 0.05) (Table 2).

6. Probing depth change: Probing depth increased from the BL values to the different intervals of the follow-up period. Statistical analysis of the mean percentage change in probing depth from the BL for MLO and MPO group showed no significant difference from BL to six month period (p > 0.05) and from BL to 12 month period (p < 0.05). Comparison of the mean percentage changes of probing depth from the BL values for the MLO versus the MPO group showed no significant differences at the different intervals of the follow-up period (p > 0.05) (Table 3).

7. Bone height change: Bone height decreased significantly (p < 0.05) from the BL values to the different intervals of the follow-up period. Statistical analysis of the mean percentage change in bone height from the BL for MLO group revealed a significant difference from BL to six month period (p < 0.05) and from BL to 12 month period (p < 0.05). Statistical analysis of the mean percentage change in bone height from the BL of the MPO group revealed a significant difference from BL to six month period (p < 0.05) and at 12 month (p > 0.05). Comparison of the mean percentage changes of bone height from the baseline values for the MLO versus the MPO group showed no significant differences at the different intervals of the follow-up period (p > 0.05) (Tables 4, 5).

### Table 1: Comparisons of gingival index change in both groups from the baseline values at the different intervals of the follow-up period. (*Significant (p < 0.05), NS = Non-Significant (p > 0.05))

<table>
<thead>
<tr>
<th>Group</th>
<th>Parameter</th>
<th>BL - 6m</th>
<th>BL - 12m</th>
<th>6m - 12m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median lingualized occlusion</td>
<td>Mean difference</td>
<td>0.6667</td>
<td>1.667</td>
<td>1.0003</td>
</tr>
<tr>
<td>(MLO)</td>
<td>p-value</td>
<td>0.1835</td>
<td>0.0377</td>
<td>0.0102</td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>*</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Monoplane occlusion</td>
<td>Mean difference</td>
<td>0.6667</td>
<td>1.333</td>
<td>0.6667</td>
</tr>
<tr>
<td>(MPO)</td>
<td>p-value</td>
<td>0.1835</td>
<td>0.05</td>
<td>0.1835</td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>*</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

Comparison of mean % changes (MLO vs. MPO)

<table>
<thead>
<tr>
<th>p-value</th>
<th>1</th>
<th>0.5185</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>
Discussion

The patients were selected free from any systemic diseases and were completely edentulous for at least six months before implant insertion and the patients with abnormal ridge relationship were not included in this study to avoid subjecting the implants to abnormal forces and to facilitate the surgical steps [11], the Patients with bad habits as bruxism and clenching were excluded to avoid the parafunctional loads which increase the risk of abutment screw loosening.

Table 2: Comparisons of plaque index change in both groups from the baseline values at the different intervals of the follow-up period (* Significant (p < 0.05), NS = Non-Significant (p > 0.05))

<table>
<thead>
<tr>
<th>Group</th>
<th>Parameter</th>
<th>BL - 6m</th>
<th>BL - 12m</th>
<th>6m -12m</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median lingualized occlusion (MLO)</td>
<td>Mean difference</td>
<td>0.6667</td>
<td>1.333</td>
<td>0.6667</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.1835</td>
<td>0.05</td>
<td>0.1835</td>
<td>NS</td>
</tr>
<tr>
<td>Monoplane occlusion (MPO)</td>
<td>Mean difference</td>
<td>0.6667</td>
<td>1.333</td>
<td>0.6667</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.1835</td>
<td>0.05</td>
<td>0.1835</td>
<td>NS</td>
</tr>
</tbody>
</table>

Table 3: Comparisons of probing depth change in both groups from the baseline values at the different intervals of the follow-up period (* Significant (p < 0.05), NS = Non-Significant (p > 0.05))

<table>
<thead>
<tr>
<th>Group</th>
<th>Parameter</th>
<th>Baseline</th>
<th>6 months</th>
<th>12 months</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median lingualized occlusion (MLO)</td>
<td>Minimum</td>
<td>13.74</td>
<td>13.17</td>
<td>12.81</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>13.93</td>
<td>13.49</td>
<td>13.14</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>13.83</td>
<td>13.34</td>
<td>12.99</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>0.07132</td>
<td>0.131</td>
<td>0.1311</td>
<td>*</td>
</tr>
<tr>
<td>Monoplane occlusion (MPO)</td>
<td>Minimum</td>
<td>13.72</td>
<td>13.23</td>
<td>12.64</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>14.03</td>
<td>13.53</td>
<td>12.92</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>13.87</td>
<td>13.38</td>
<td>12.78</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>0.1202</td>
<td>0.1194</td>
<td>0.1129</td>
<td>*</td>
</tr>
</tbody>
</table>

Table 4: Bone height of median lingualized occlusion (MLO) and monoplane occlusion (MPO) groups at the different intervals of the follow-up period

<table>
<thead>
<tr>
<th>Group</th>
<th>Parameter</th>
<th>BL - 6m</th>
<th>BL - 12m</th>
<th>6m -12m</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median lingualized occlusion (MLO)</td>
<td>Mean difference</td>
<td>-0.49</td>
<td>-0.84</td>
<td>-0.35</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Mean % change</td>
<td>-3.54302</td>
<td>-6.07375</td>
<td>-2.62369</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.0001</td>
<td>0.000</td>
<td>0.000</td>
<td>*</td>
</tr>
<tr>
<td>Monoplane occlusion (MPO)</td>
<td>Mean difference</td>
<td>-0.49</td>
<td>-1.09</td>
<td>-0.6</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Mean % change</td>
<td>-3.5328</td>
<td>-7.85869</td>
<td>-4.4843</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.001</td>
<td>0.000</td>
<td>0.000</td>
<td>*</td>
</tr>
</tbody>
</table>

Table 5: Comparisons of bone height change in both groups at the different intervals of the follow-up period (*Significant (p < 0.05), NS = Non-Significant (p > 0.05))

Lack of proper oral hygiene was reported as one of the main causes of osseointegration failure, also the smokers were also excluded because these patients may exhibit generalized bone loss to the implants due to compromising the blood supply in bone during healing [12].

The mandibular arch was selected for implant placement because problems involving lack of stability and retention were always encountered with mandibular denture [13]. The implants were placed in the region of the cuspsids in between the two mental foramina at best bone quality and to avoid injury to the inferior alveolar nerve in the posterior region of the mandible. In order to solve the problem of poor retention, each patient received mandibular overdenture retained by ball and socket on the two implant fixtures as recommended in many studies [14].

**Occlusion**

Occlusion is critical for implant longevity because of the nature of the attachment of the bone to the titanium-surfaced implant. In the natural dentition, the periodontal ligament has the capacity to absorb stresses or allow for teeth movement but the bone implant interface seemingly has no capacity to allow movement of the implant. Any stress from occlusion must be borne totally by the interface. If occlusal force exceeds the capacity of the interface to absorb stress, the implants will fail [15].

Cross linked acrylic resin teeth were used instead of porcelain teeth, as they act as shock absorber preventing the transfer of undue stresses to the implants.

Some researchers have accepted the concept of linguallized (lingual contact) occlusion as the contemporary occlusal scheme of choice for implant supported removable denture restorations [16]. Some of the many advantages of linguallized occlusion is it applies to implant supported removable restorations include; occlusal forces that are centered over the ridge crest in centric relation, effective transfer of forces more “lingual” to the ridges during working side excursions and minimized occlusal disharmonies created from errors in jaw registrations, denture processing changes and / or eventual settling of the denture base [17].

The monoplane occlusion of posterior teeth were arranged in a horizontal plane antero-posteriorly and medio-laterally. The occlusal plane should be midway between the upper and lower ridges, parallels the mean foundation plane and end at the junction of the upper and middle thirds of the retromolar pad. The cuspal inclines of posterior teeth reduce the horizontal forces transferred to abutments, thus maintaining and preserving the alveolar bone surrounding the implants [18].

On the other hand, monoplane occlusion was recommended for severely resorbed ridge because the steep cusp angles may cause destabilizing horizontal forces [19].

The result of the present study showed no significant difference in the mobility between both groups, which might be attributed to the stability of the overdentures and stress control followed in overdenture construction [20]. Percussion on the implants for both groups revealed a solid ringing sound indicating direct contact between the bone and implants i.e. successful osseointegration.

The non significant decrease in plaque index in both groups might be attributed to that, routine hygienic procedures by which the health of the gingival margin is normally maintained and would seem to be adequate after the prosthesis has been fitted, or in other words the ball abutments were easily cleaned which allowed the patients to follow strict oral hygiene measures to control plaque accumulation around the implant, these observations confirm the results study by Gotfredsen and Holm [21], Who referred their results to the strict oral hygiene that the patients followed.

In this study, there was insignificant increase of the probing depth around the implants in both groups through the follow-up period. These results are in agreement with Mericske-stern and Zarb [22], due to maintenance of oral hygiene and to the balanced occlusion that minimized the loads on the opposing implant retained overdenture and thus minimized pocket depth and loss of epithelial attachment [23].

Results from this study showed that marginal bone loss values as well as soft tissues peri-implant parameters around implants did not differ between the two groups and were consistent with those reported by other authors. These results were in accord with author who found that peri-implant tissues are not affected by occlusal schemes [24].

The difference between the bone losses around the implant fixtures in the two groups was not statistically significant during the follow-up periods. Throughout the observation period, both groups showed marginal bone loss related to implant abutments in both groups after one year follow-up did not exceed than 0.1mm, hence all implants were considered successful [25].

The results of this study were in agreement with the studies of Naert, et al [26], who found that the radiographic annual bone loss around fixtures in the lower jaw was nearly 0.8 mm for the first year and less than 0.1 mm for the following years. Also Mohamed and Ibrahim [27], concluded near the similar results; they found mean loss of 0.95 mm in the first year.

The results of this study differed from the results of some authors [28,29], who reported that the mean bone loss during the functional period of one year ranged from 0.3-0.6 mm. This difference may be due to the difference in the type of implant or the type of attachment.

**Conclusions**

From the results of this study, it was concluded that there was no statistically significant difference between median linguallized occlusion and monoplane occlusion in implants supporting a mandibular ball and socket-retained overdenture. From the clinical point of view, satisfactory results were obtained when two dental implants placed in the intraforaminal region of the mandible and connected with ball and socket attachment to support and retain mandibular overdenture. These satisfactory results were obtained with median linguallized occlusion as well as with monoplane ones.

**References**


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