Comparative Evaluation of Two Different Castable Bar Attachments in Implant Retained Mandibular Overdenture Cases

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COMPARATIVE EVALUATION OF TWO DIFFERENT CASTABLE BAR ATTACHMENTS IN IMPLANT RETAINED MANDIBULAR OVERDENTURE CASES

Fardos N. Rizk

ABSTRACT

Objective: This research was carried to evaluate which solitary attachment; OT Cap Ball attachment or OT Cap Equator Profile attachment mounted on a bar splinting two implants retaining mandibular overdenture is more favorable regarding crestal bone height and bone density changes surrounding the implants using cone beam computed tomography.

Materials and Methods: Following two stage surgical protocol twelve completely edentulous patients received two implants placed bilaterally in the canine region (24 implants) to retain mandibular overdenture. Four months following the surgery patients were randomly divided into two equal groups; Group-I received two OT Cap Ball attachments mounted on a bar splinting the implants, while Group-II received two OT Cap Equator Profile attachments mounted on a bar splinting the implants upon which mandibular overdentures were retained in both groups. Once patients were comfortable to the prosthesis, they were placed on zero, six and twelve months follow-up periods using cone beam computed tomography. Measurements were taken on crestal bone height and bone density changes surrounding the implants then the results were statistically analyzed.

Results: There was decrease in mean value of crestal bone height and increase in mean value of bone density surrounding the implants throughout the study period in both studied groups however, there was statistically none significant difference between the two studied groups whether in the decrease of crestal bone height or in the increase of bone density.

Conclusion: There is no difference between using castable bar supporting either Ball attachment or Equator profile attachment retaining mandibular overdenture regarding the crestal bone height and bone density changes surrounding the implants.

KEY WORDS: Implants, Bar attachment, OT Cap Equator profile attachment, OT Cap Ball attachment, Overdenture, Cone Beam Computed Tomography

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INTRODUCTION

Lack of retention and stability of the mandibular denture is a common problem among edentulous denture wearers. Initially, treatment with endosseous implants consisted of the placement of four to six implants in combination with a fixed prosthesis. It proved quite successful. Implant overdenture treatment was adopted later and long-term clinical results were shown to be excellent as well. Over the years, much experience has been gained regarding the benefits of two-implant-retained mandibular overdentures. It was demonstrated convincingly in well-designed clinical trials that two-implant-retained overdentures provide superior function and satisfaction when compared to conventional dentures and preprosthetic surgery in patients with persistent denture complaints. It is even considered to be the standard of care in cases of mandibular edentulism. Using more than two implants to support an overdenture generally has no obvious clinical, functional and subjective advantages.

A large number of retentive devices are currently available presenting a wide range of function and fabrication complexity. In general, implant-supported overdenture attachments can be classified as studs, magnets, and bars. Determinants for attachment selection include jaw morphology and anatomy, retention required from the prosthesis, number of implants, the length of the bar, dexterity, patient’s expectation, financial capabilities of the patients and inclination of implants where implants with poor angulation are often splinted with a bar and connected to the overdenture with attachments.

Although magnets and studs provide more favourable load transfer to bone and are less expensive and easier to use, bar and clip attachments provide greater retention and stability, permit splinting of implants and can mask excessive residual ridge atrophy. A variety of bar designs has been advocated. A common bar attachment assembly for overdenture is the one-piece cast bar, connecting the abutments. In trying to modify the form of the bar, Leonard et al. presented procedure for fabrication of cobalt-chromium milled bar with four ball attachments supporting a mandibular overdenture and found that the prosthesis met the requirements of masticatory efficiency, natural esthetics and maintenance of health of residual tissues.

Ball attachments are associated with a lower level of implant moment loading because they allow movement without resisting horizontal forces. Nowadays in addition to ball attachments a variety of variable resilient stud attachments are available including Locator and OT Equator Profile attachment. OT Equator Profile attachment takes the form of the central portion of the sphere which is the real working retentive area thus reducing the vertical dimension of the sphere without compromising its full functionality. It is available in various degrees of retention and it has the advantage of being resilient thus lowering the stress placed on bone surrounding the implants than rigid attachments. Splinting the implants with a bar carrying resilient stud attachments combines the advantages of the bar including splinting and improving the stabilization of the prosthesis with the advantage of less load transfer to bone provided by the freedom of movement of the stud attachment.

This research was carried to evaluate which solitary attachment; OT Cap ball attachment or OT Cap Equator Profile attachment mounted on a bar splinting two implants retaining mandibular overdenture is more favorable regarding crestal bone height and bone density changes surrounding the implants using cone beam computed tomography.

MATERIALS AND METHODS

Patients Selection

Patients eligible for the study were male patients, completely edentulous for at least one year and for no more than three years with age ranging
between 52 to 67 years and for whom a decision had already been made to incorporate dental implants for the treatment of complete edentulism. Diagnostic cone beam computed tomography was taken for each patient. Patients with bone density ranging from 850-1250 HU (D2) and bone height and width more than 13mm and 5mm respectively in the anterior region of the mandible (Division A) were included in the study. Exclusion criteria included inadequate interarch distance, severe maxillomandibular skeletal discrepancy, clenching habits, bruxism, tempromandibular joint disorders, smokers, drug abuse, history of head and neck radiation and systemic disorders that may prevent surgery, affect bone quality or contribute to bone resorption. Following this criteria twelve qualified patients were chosen and motivated to the treatment.

**Surgical Procedures**

For each patient two implants (Tut Dental Implant System, ECDI Cairo, Egypt) with dimensions (3.7 x 13mm) were inserted bilaterally in the canine region at equal distance from the mid line, parallel to each other and perpendicular to the occlusal plane. All implants were placed by the same oral surgeon using surgical template and following two stage surgical protocol. Covering screws were threaded into the implants which were left to heal for four months. Osseointegration of the implants was verified by digital panoramic radiographs.

**Prosthetic Procedures**

Following four months healing period, the implants were exposed to receive healing abutments. For each patient an alginate impression (Alginmax, Major Prodotti. Dentari SPA. Moncalieri. Italy) was made using stock tray to pour a cast upon which a special tray was made. Two weeks later the healing abutments were replaced with castable plastic cylinder bar abutments (Tut Dental Implant System, ECDI Cairo, Egypt) which were screwed into position with retaining screws (Fig1). Definitive impression of the abutments and the residual ridge was taken with closed tray (indirect impression technique) using medium body rubber base (Swiss TEC, Coltene, Whaledent, Altstatten, Switzerland) manipulated according to the manufacturer’s instructions. After removal of the impression from the patient’s mouth, the castable plastic cylinder abutments were unscrewed to be replaced by the healing abutments. The implant replicas were screwed into the castable plastic cylinder abutments which were fitted carefully in the impression to pour the definitive cast for fabrication of the bar (Fig2).

**Bar Fabrication**

In the twelve cases castable plastic pattern of OT bar was cut to a suitable length and adhered to the castable plastic cylinder abutments on the definitive cast. Two marks were made to divide the bar into
three equal thirds and two OT castable plastic Ball attachments were adhered on the two marks in six cases and two OT castable plastic Equator profile attachments were adhered on the two marks in the other six cases. The overdenture bar, attachments and abutments were casted following the conventional casting methods in cobalt-chromium alloy (Remanium GM 380+; Dentaurum, Ispringen, Germany) (Fig.3,4).

**Patient Randomization**

Patients were randomly divided into two equal group

**Group I:** Each patient received OT Bar (OT bar Multiuse attachments, Cas, RHEIN 83, ITALY) with two OT Cap Ball attachments (OT Cap attachments, Cas, RHEIN 83 Italy) (Fig.3).

**Group II:** Each patient received OT Bar (OT bar Multiuse attachments, Cas, RHEIN 83, ITALY) with two OT Cap Equator profile attachments (OT Cap attachments, Cas, RHEIN 83 Italy) (Fig.4).

The assembly was tried in each patient’s mouth and checked for marginal fit, contour and accurate seating then it was screwed (Fig.3,4).

**Denture Fabrication**

For each patient upper and lower primary alginate impressions (Alginmax, Major Prodotti, Dentari SPA, Moncalieri, Italy) were made, to obtain study casts upon which special trays were made. Upper and lower final impressions were made using medium body rubber base (Swiss TEC, Coltene, Whaledent, Altstatten, Switzerland) to obtain master casts upon which occlusion blocks were made. Centric occluding relation was recorded following the conventional wax wafer technique. Setting up of teeth was done according to modified linguinalized occlusion using modified cuspless teeth (Vita-pan acrylic teeth, Vita Bad Sackingen-Germany). The waxed up denture was tried in the patient’s mouth, then flasked and processed into high impact heat cure acrylic resin (Lucitone199, Dentsply, York, PA-USA). Laboratory remounting was done before finishing the denture and occlusal discrepancies were adjusted.

**Pick up procedures of the female part of the attachment**

For each patient the fitting surface of the overdenture was relieved to accommodate the newly inserted white standard retentive caps with their metalloic housings fitted on the OT Ball attachments in group one and the white standard retentive caps with their metalloic housings fitted on the OT Equator profile attachments in group two. Any undercuts were blocked out using temporary filling (Litark, LascoD SpA-Vita L. Longo, Sesto F. no Firenze Italy). Self cure acrylic resin (Lucitone 199; Dentsply) was inserted in the relieved areas to pick up the retentive caps with their metallic housings and the patients were instructed to close

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*Fig. (3): OT Bar with two OT Cap Ball attachments*

*Fig. (4): OT Bar with two OT Cap Equator profile attachments*
in centric until complete polymerization has taken place. Any excess material was removed and the mandibular overdentures were removed and left for bench curing for about 30 minutes (Fig. 5). Any necessary adjustments were carried out to eliminate occlusal interference and the dentures were inserted in the patients’ mouths (Fig. 6). Dentures were checked after 24 and 72 hours for any needed adjustment and to ensure that the patients were satisfied with esthetic, stability and retention of the dentures. Patients were instructed to maintain strict oral hygiene measures and return for recall appointments after six and twelve months.

**Linear measurements for evaluation of crestal bone height**

Mesial and distal crestal bone levels were calculated from panoramic views by drawing a line parallel to the implant serration extending from the crestal bone to the apical end of the implant (Fig. 7). Similarly, buccal and lingual bone levels were calculated by using the cross-sectional views. Average readings of the four surfaces at each interval were calculated and tabulated for statistical analysis.

**Linear measurements for evaluation of bone density**

The density measurements were performed by calculating the CT numbers 1 mm away from the surface of each implant at all buccal (B) and lingual (L) sides (cross sectional views) and mesial (M) and distal (D) sides (panoramic views). Therefore each implant had four CT numbers (B, L, M, D) indicating the quality (density) of bone engaged with the threads of the implant (Fig. 7). Average readings of the four sides at each interval were calculated and tabulated for statistical analysis.

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Fig. (5): Fitting surface of the denture with the retentive caps in their metallic housings  
Fig. (6): Denture inserted in the patient’s mouth  
Fig. (7): Assessment of mesial and distal creatal bone height and bone density on CBCT
Statistical analysis

The statistical analysis of data was done by using excel program and SPSS program (statistical package for social science) version 16 on windows xp. Mean ± SD for normally distributed quantitative data was performed.

The analysis of data was done to test statistical significant difference between groups for quantitative data normally distributed (mean ± SD)

Paired and unpaired student t-tests were used to compare the two studied groups.

P value is significant if ≤ 0.05 at confidence interval of 95%

TABLE (I): Effect of time on crestal bone height surrounding the implants in both studied groups at different intervals of follow-up period.

<table>
<thead>
<tr>
<th>Period</th>
<th>Group I: OT Bar and OT Cap Ball attachment</th>
<th>Group II: OT Bar and OT Cap Equator profile attachment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (mm) SD</td>
<td>Mean (mm) SD</td>
</tr>
<tr>
<td>At-insertion</td>
<td>12.15 0.41</td>
<td>12.00 0.44</td>
</tr>
<tr>
<td>At- 6 months</td>
<td>11.73 0.43</td>
<td>11.59 0.44</td>
</tr>
<tr>
<td>At 12 months</td>
<td>11.21 0.42</td>
<td>11.09 0.49</td>
</tr>
<tr>
<td></td>
<td>paired t- value P value</td>
<td>paired t- value P value</td>
</tr>
<tr>
<td>0-6 months</td>
<td>22.42 0.00000 **</td>
<td>19.46 0.00000 **</td>
</tr>
<tr>
<td>0-12 months</td>
<td>41.66 0.00000 **</td>
<td>31.4 0.00000 **</td>
</tr>
<tr>
<td>6-12 months</td>
<td>29.35 0.00000 **</td>
<td>17.31 0.00000 **</td>
</tr>
</tbody>
</table>

* p value < 0.05: significant. ** p value < 0.01: highly significant. ns= P value >0.05: non-significant

TABLE (II): Comparison between crestal bone height changes surrounding the implants in both studied groups at different intervals of follow-up period.

<table>
<thead>
<tr>
<th>Period</th>
<th>Group I: OT Bar and OT Cap Ball attachment</th>
<th>Group II: OT Bar and OT Cap Equator profile attachment</th>
<th>Unpaired t-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean difference (mm) SD</td>
<td>Mean difference (mm) SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-6 months</td>
<td>0.42 0.07</td>
<td>0.41 0.07</td>
<td>0.39</td>
<td>0.705 ns</td>
</tr>
<tr>
<td>6-12 months</td>
<td>0.52 0.06</td>
<td>0.50 0.10</td>
<td>0.49</td>
<td>0.629 ns</td>
</tr>
<tr>
<td>0-12 months</td>
<td>0.94 0.08</td>
<td>0.91 0.10</td>
<td>0.75</td>
<td>0.462 ns</td>
</tr>
</tbody>
</table>

* p value < 0.05: significant. ** p value < 0.01: highly significant. ns= P value >0.05: non-significant
Bone Density

There was increase in mean value of bone density surrounding the implants throughout the study period in both groups. This increase was highly significant in both groups through all intervals of follow-up period as shown in table III.

There was statistically none significant difference between the two studied groups in the increase of bone density surrounding the implants through all intervals of follow-up period as shown in table IV and Fig. 9.

TABLE (III): Effect of time on bone density surrounding the implants in both studied groups at different intervals of follow-up period.

<table>
<thead>
<tr>
<th>Period</th>
<th>Group I: OT Bar and OT Ball Cap attachment</th>
<th>Group II: OT Bar and OT Cap Equator profile attachment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (HU)</td>
<td>SD</td>
</tr>
<tr>
<td>At-insertion</td>
<td>975.49</td>
<td>186.70</td>
</tr>
<tr>
<td>At- 6 months</td>
<td>1047.07</td>
<td>186.00</td>
</tr>
<tr>
<td>At 12 months</td>
<td>1108.99</td>
<td>173.02</td>
</tr>
<tr>
<td>paired t- value</td>
<td>P value</td>
<td>0.00000 **</td>
</tr>
<tr>
<td></td>
<td>9.81</td>
<td>0.00000 **</td>
</tr>
<tr>
<td></td>
<td>16.31</td>
<td>0.00000 **</td>
</tr>
<tr>
<td></td>
<td>9.53</td>
<td>0.00000 **</td>
</tr>
</tbody>
</table>

* p value < 0.05: significant. ** p value < 0.01: highly significant. ns= P value >0.05: non-significant

TABLE (IV): Comparison between bone density changes surrounding the implants in both studied groups at different intervals of follow-up period.

<table>
<thead>
<tr>
<th>Period</th>
<th>Group I:</th>
<th>Group II:</th>
<th>Unpaired t-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean difference (HU)</td>
<td>SD</td>
<td>Mean difference (HU)</td>
<td>SD</td>
</tr>
<tr>
<td>0-6 months</td>
<td>-71.58</td>
<td>25.27</td>
<td>-61.15</td>
<td>19.32</td>
</tr>
<tr>
<td>6-12 months</td>
<td>-61.92</td>
<td>22.51</td>
<td>-71.91</td>
<td>31.10</td>
</tr>
<tr>
<td>0-12 months</td>
<td>-133.50</td>
<td>28.36</td>
<td>-133.06</td>
<td>31.39</td>
</tr>
</tbody>
</table>

* p value < 0.05: significant. ** p value < 0.01: highly significant. ns= P value >0.05: non-significant
An implant-supported mandibular overdenture with only two implants is a simple treatment in edentulous subjects. Due to limited financial resources and because the number has been shown to be of minor importance, the number of implants was restricted to two. Implants were placed in the canine region bilaterally (B and D) regions as in this position the bar splinting these implants is straight rather than curve, thus having less potential load per surface area compared to implants splinted in the premolar region (A and E regions) with curve bar.  

Significant decrease of crestal bone height surrounding the implants for the two groups was found through all intervals of follow-up period. This bone reduction might be considered an immediate bone reaction after insertion of the prosthesis and following the functional stresses that occurred after prosthesis connection.  

In this study crestal bone height reduction was about 0.94 mm in case of OT Cap Ball attachment and 0.91 in case of OT Cap Equator profile attachment which complies with the success criteria of Albrektsson et al., being lower than 1.5 mm yearly resorption after abutment connection. This also agrees with the findings of Goodacre et al., who reported mean marginal bone loss 0.9 mm (range from 0.4 to 1.6 mm) during the first year and with Cox and Zarb who stated that mean crestal bone loss reaching 1.6 mm is accepted as a radiographic sign for implant success during the first year of implant loading. Statistically none significant difference between the two groups was found which might be due to similarity of matrix matrix relationship of the two attachments where in both attachments the male part is connected to the bar and the female white standard retentive cap is fitted in the fitting surface of the denture. Also, Ball sizes with sphere diameter 2.5 mm were used which is nearly equivalent to the height of the Equator profile attachment being 2.1 mm.  

Both groups showed increase in bone density with statistically none significant difference between them. This agrees with the results of Quirynen et al. who demonstrated an increase in density of peri-implant bone structures over six months to four years period after implant placement. This increase is considered a positive response of bone to load applied within its physiologic limit and adaptive capacity. Since the thickness and closeness of the bone trabeculae vary directly with the stresses transmitted to them thus, the proper distribution of the load falling on the implants might have enhanced the structural orientation of bone trabeculae and hence increased the bone density around the implants. These findings are in agreement with the studies of Ghetto et al., and Baker and Goodkind.  

Misch in 2005 reported that higher bone density as well as reduced amounts of crestal bone loss were noticed around the delayed loaded implants. These findings supported the findings of Appleton et al., 2005 who noted that progressively loaded implants had increased bone density as well as reduced amount of crestal bone loss.
CONCLUSION

Within the limitations of this study it could be concluded that there is no difference between using castable bar supporting either Ball attachment or Equator profile attachment retaining mandibular overdenture regarding the crestal bone height and bone density changes surrounding the implants.

REFERENCES


