The aim of the present study was to evaluate both ZAAG and OT REVERSE/3 attachments retaining complete mandibular overdentures supported by two Legacy implants regarding both periimplant bone and residual ridge resorption and maintenance complications in patients with limited interarch space during a 2 year follow-up period. The two implants were placed in the canine region. Mandibular overdentures were provided for 12 edentulous male patients. Subjects were divided equally into ZAAG and OT REVERSE/3 groups. Once patients were comfortable, they were placed on a one week, 6, 12 and 24 months follow-up periods. Marginal periimplant bone levels and distal residual ridge height were monitored on intraoral radiographs using long cone paralleling technique. Frequency of maintenance complications were also detected during the follow-up periods. A significant decrease in periimplant bone loss was recorded in favor to the OT REVERSE/3 group. However a significant decrease in vertical residual bone loss was recorded in favor to the ZAAG group. It could be concluded that although mandibular implant–retained overdentures with OT REVERSE/3 attachments are an acceptable treatment option for edentulous patients with limited interarch space, routine maintenance is required to ensure successful long-term outcomes.

INTRODUCTION

Overdentures offer the advantages of an increased quality of life for edentulous patients and a significant contribution to these patients’ psychological well-being. In addition, implant–retained overdentures have garnered patient satisfaction greater than that with conventional complete dentures.

Removable implant–retained overdentures provide easier access for oral hygiene, easy modification of the prosthesis base and the presence of a labial flange that improves esthetics when the jaw relationship is unfavorable.

The use of 2 implants to retain the denture significantly improves the prognosis of mandibular edentulism. Recognizing this, some have considered a 2–implant–retained overdenture to be the standard of care for mandibular edentulism.
Overdentures are stabilized using attachment components such as bar and clips, ball or magnets. Several in-vitro and in-vivo investigations have studied these features and components (4,9–11). However, the amount of maintenance required to ensure long-term clinical success continues to be a concern. It was reported that post-insertion adjustments were more common for overdentures prostheses during the first year (12–14).

A critical factor that needs to be evaluated during the diagnosis and treatment planning phase for patients seeking an implant–tissue–supported overdenture is the presence of adequate interarch distance (15). This space is required to ensure adequate restorative material thickness, space for the retentive elements, esthetics and cleansability (16).

Inadequate space for prosthetic components can result in an overcontoured prosthesis, excessive occlusal vertical dimension, fractured teeth adjacent to the attachments, attachments separating from the denture, fracture of the prosthesis and overall patient dissatisfaction (17).

The estimated interarch space required for an implant–retained overdenture measured from the implant shoulder to the incisal edge is approximately 12 to 14 mm. Two to 3 millimeters of soft tissue thickness is generally present above the implant and 2 mm of space from the edentulous ridge mucosa to the bar is recommended for cleansability (18), 4.5 mm for the bar, 2 mm for the acrylic resin and clip housing and 3 mm for the teeth above the denture base (19).

The height of most ball attachments, including the height of the ball abutment and the O–ring, is approximately 5 to 6 mm. Hence, patients with well-preserved alveolar ridges having lost teeth due to caries may have inadequate interarch space for an implant–retained overdenture. Limited interarch space often restricts the prosthetic armamentarium to low–profile attachments and prevents the use of O–ring attachments and bars (19).

These series of various intra–radicular attachments were used in all prosthetic projects, in overdenture on roots or implants and in combined prostheses. Many previous attempts to construct overdenture attachments based on reverse concepts all produced unsatisfactory results, if the retention “Male made from metal” was a strong and solid construction. The lack of elasticity produced a functionality that was too rigid. Other projects constructed with “Elastic males” made from plastic, were too weak and fragile and at times, this created a high-risk situation, because when the prosthesis is not inserted correctly by the patient, the elastic male bends and loses the line of insertion. When this happens the patient is no longer able to insert the prosthesis, the dentist must intervene and change the deteriorated plastic male (20, 21).

Zest advanced anchorage generation [ZAAG] attachment, is a modern intraradicular stud attachment, similar to but not inter-changeable with the Zest attachment. The ZAAG nylon male is encased in a metal housing that allows the male to pivot. This feature prevents bending of the male. Worn males are easily replaced at chair side into the metal housing (22, 23). In the OT REVERSE / 3 attachments the male is constructed in titanium with a design that made it particularly elastic and robust, functionality and resistance are assured even in cases when it is improperly inserted. Both ZAAG and OT REVERSE / 3 attachments have a vertical height of about 3.5 mm and classified and function as resilient universal hing attachments which allow pivoting and rotational movements (22).

Hence, the aim of the present study was to evaluate both ZAAG and OT REVERSE / 3 attachments retaining complete mandibular overdentures supported by two Legacy implants regarding both periimplant bone and residual ridge resorption and maintenance complications in patients with limited interarch space during a 2-year follow-up period.
MATERIALS AND METHODS

Twelve male fully edentulous patients with age ranging from 38 – 54 years (mean 46 y) participated in this study.

All the patients had been completely edentulous for at least 5 years, with an apparent detection of narrow interarch space.

To be included in this study, patients were selected to have good physical and mental health, sufficient bone of good quality and quantity to support implants evaluated in panoramic and lateral cephalometric radiographs to allow the use of 13 mm implants in the symphyseal area.

Patients were excluded if they had diabetes, history or presence of diseases that may negatively influence the treatment, known alcohol and / or drug abuse, clinical or radiographic signs of pathologic processes of the mandible, history of recurrent aphthous ulceration, bruxism, gagging reflex and extreme maxilla-mandibular skeletal discrepancies (Angle’s Class II or III).

Primary and final elastomeric impressions were made for each patient. Maxillo-mandibular relationships were obtained with the use of stabilized record bases with occlusion rims. Setting-up of teeth following esthetic tooth evaluation and balanced lingualized occlusal scheme was established. Following try-in stage approval, duplication of the lower waxed-up denture was done. On the duplicate cast, a vacuum pressed mandibular template was performed. The lower waxed-up denture was removed from the articulator and the vacuum pressed template was placed directly on the ridge after drilling a hole at the incisal tip of the canine index area bilaterally. A periodontal probe carrying a stopper was then used to measure the space from the ridge to the tip of the canine (Fig. 1). All selected patients must have narrow interarch space, where the measured height is about 6–8 mm, putting in consideration a mucosal thickness of 2 mm.

To assure ideal implant placement that was harmonious with osseous anatomy, denture esthetics and attachment connection; dentures were fabricated prior to implant surgery.

Following denture placement and adjustments and patient adaptation, the mandibular denture was duplicated in clear acrylic resin and used as a surgical template. This assured that implants were placed beneath the planned prosthetic attachment location, which was determined, in part, by ideal denture contour and esthetics.

Two endosseous Legacy implants (Implant Direct LLC, USA, Canada) measuring 3.7 × 13 mm in dimension, with 3.5 mm diameter platform and internal connections were used. They are SBM surface implants, which are the next generation of Zimmer’s tapered screw-vent implants. Aided by the surgical guide, implants were placed at the canine region, parallel to each other and perpendicular to the occlusal plane. Moreover, they were placed at the same occlusal height and nearly at equal distance off the mid line (24). Two mm healing colars were secured on the implants after evaluating primary stability. After implant placement, conventional surgical protocols often mandate a 2-week initial healing period. During this time no prosthesis should be used over the implant surgical site so that early healing can occur without functional loading. After this 2-week period, the tissue surface
of the existing overdenture was relieved in the area overlying the healing collar. Resilient relining material was placed into the relief area to restore intimate tissue contact. Implants were usually allowed to integrate for a minimum of 4 months. Osseointegration of the implant was radiographically verified in panoramic radiographs before the abutment connection.

Patients were then randomly divided into two groups of equal size, but with different intraradicular resilient attachment systems, ZAAG group and OT REVERSE / 3 group. Both attachments are designed for narrow inter-arch space (Fig. 2, 3). The attachment systems examined were as follows:

**ZAAG attachment:** [Zest Anchor Advanced Generation]: It is composed of Zest abutment of Legacy implant (Zest Anchors Inc, Escondido, CA) and Zest nylon Key males with spacers encased in a dome shaped gold coloured metal housing. Overall height of male is 3.5 mm which pivots into the housing and the diameter of the sphere is 2.1 mm (Fig. 4).

**FIG. (2)** Low profile female portion of the ZAAG attachment

**FIG. (3)** Low profile female portion of the OT REVERSE/3 attachment

**FIG. (4)** Female portion of the ZAAG attachment.

**OT REVERSE / 3 attachment:** It is composed of titanium + Tin abutment, retentive male titanium bifid sphere + white nylon cap. The overall height of the retentive male is 3.6 mm, with a sphere height 2.16 mm and diameter 1.8 mm. It is provided with stainless steel housing for picking-up in the denture (Fig. 5, 6).

**FIG. (5)** Titanium abutment, retentive male titanium bifid sphere and white nylon cap of OT REVERSE/3 attachment
The mandibular denture base was relieved to accommodate for the attachment height. Abutments were threaded and unthreaded for 3–4 times to accommodate perfect adaptation of the screw to the internal implant threads. The overdenture is checked for the relived attachment space intraorally.

Under close-mouth technique, direct picking-up was done through the holes made opposite to the attachment sites using injection self-cured acrylic resin. Protective discs were used during picking-up to avoid infiltrations (Fig. 7). Once the resin is hardened, the denture is cleaned and polished (Fig. 8, 9). A bilaterally balanced occlusal scheme was verified clinically, ensuring equal distribution of posterior contacts with no anterior contacts. The dentures were inserted and pressure areas were identified using pressure indicating paste (Mizzy Inc., Cherry Hill, NJ).

Patients were instructed to follow strict oral hygiene measures. They were recalled for follow-up visits 1 week after prosthesis insertion and 6, 12, 24 months later on.

Long cone paralleling technique (25), was followed using the Rinn – XCP periapical film holder [Rinn corporation, XCP instruments for extension cone paralleling technique, IL, USA] to measure the changes in the height of both the periimplant bone [mesial & distal aspects] and the residual ridge distal to the implants.

A radiographic template was constructed on a mandibular primary cast, for each patient. The template encloses an orthodontic wire 0.9 mm in diameter notched and contoured parallel to the crest of the ridge and

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**FIG. (6)** Female portion of the OT REVERSE/3 attachment.

**FIG. (7)** Protective discs were used during picking-up to avoid infiltrations.

**FIG. (8)** Fitting surface of the overdenture with the male portion of ZAAG attachment.

**FIG. (9)** Fitting surface of the overdenture with the male portion of OT REVERSE/3 attachment.
abutments. The notches were made one and two cm distal to the implants to be within the premolar-molar region. The technique used by Mady was followed to measure the changes in the residual ridge height. The change was measured at vertical lines extended perpendicular to each notch at one and two cm distal to implant abutments. Right and left measurements were taken at each follow-up period where the orthodontic wire was considered as the reference point. 

Exposure time was 0.2 sec. at 65 Kvp and 10 mA, intraoral size 2, double-film packets were used (EKTA speed, Kodak, USA). One film was developed and interpreted to assure accurate projection geometry, while the other film was processed at the end of the study period at the same session using an automatic processor (Kodak, Eastman, USA). All films were digitized using a drum scanner (Optrex Technology Corporation, Mode Photomarker 3 FDC). DBS WIN version II (Durr Dental Gm and Co KG, Germany) computer program was used to measure priimplant crestal bone height. All films were stored on the computer memory. For standardization of the measurements and for guarding against any technical or human errors as well as any geometric dimensional distortion, the apparent radiographic length of each implant was measured on each of the studied images (distance between line B and C) and compared to actual known length of the implant (13 mm). Any change in length of the implant was considered a geometric projection error and was compared to the measured bone height and corrected mathematically. Line A was drawn parallel to the long axis of the implant. A fixed point at the base of the implant was marked and a line (line B) extending tangentially through this point was drawn parallel to another two lines at the implant abutment interface (line C) and the highest level of the periimplant bone (line D). The distance between line B and D represented the radiographic periimplant bone height.

Maintenance complications during the follow-up periods were registered including, nylon cap wear and replacement, correction of overdenture border, overdenture fracture / remade, overdenture reline, maxillary denture reline and minor occlusal adjustments. The data obtained were gathered, tabulated and statistically analyzed.
RESULTS

By the end of the study period, all implants showed successful osseointegration.

An analysis of variance [ANOVA] with a repeated measurement was carried out to compare between the two groups under all integrated factors with respect to periimplant and residual ridge bone heights.

### TABLE (1) Periimplant bone loss (mm) in both groups at different follow-up intervals.

<table>
<thead>
<tr>
<th>Interval</th>
<th>ZAAG</th>
<th>OT REVERSE / 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MD ± SD</td>
<td>MD ± SD</td>
</tr>
<tr>
<td>1 W – 6 m</td>
<td>0.59 ± 0.31</td>
<td>0.39 ± 0.19</td>
</tr>
<tr>
<td>1 W – 12 m</td>
<td>0.98 ± 0.40</td>
<td>0.69 ± 0.31</td>
</tr>
<tr>
<td>1 W – 24 m</td>
<td>1.2 ± 0.50</td>
<td>1.0 ± 0.40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effects</th>
<th>P. value ≠</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>0.037</td>
<td>Yes</td>
</tr>
<tr>
<td>Time</td>
<td>0.007</td>
<td>Yes</td>
</tr>
<tr>
<td>Group * time</td>
<td>0.01</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Values are mean difference ± standard deviation (MD ± SD)
≠ P. value ≤ 0.05 is considered significant.

Periimplant bone loss

The periimplant bone loss was measured at the mesial and distal sides of both the right and left implants in each group. The gained values showed no statistical difference in both groups. Therefore, the data gained were gathered with respect to the mesial and distal side of each implant and the right and left implant in both groups. Means and standard deviations of bone loss were calculated at the 1st interval (1 week – 12 months), 2nd interval (1 week – 12 months) and third interval (1 week – 24 months) *(Table 1).*

An average bone loss of 0.59 and 0.39 mm for the ZAAG and OT REVERSE / 3 groups was respectively observed after 6 months from denture insertion.

There was a significant increase in bone resorption by time for the ZAAG and OT REVERSE / 3 groups till the end of the second year follow-up to reach 1.2 and 1.0 mm, respectively. A significant difference in the periimplant bone loss between the groups was seen at each interval. Additionally, a significance of group / time interaction was noticed since the change in the amount of bone loss was different in both groups *(Fig. 12).*

### TABLE (2): Changes in the height of the residual ridge (mm) at two lines located at the premolar-molar region in the two groups at different follow-up intervals.

<table>
<thead>
<tr>
<th>Intervals</th>
<th>Line</th>
<th>ZAAG</th>
<th>OT REVERSE / 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MD ± SD</td>
<td>MD ± SD</td>
</tr>
<tr>
<td>1 w – 6 m</td>
<td>(1)</td>
<td>- 0.028 ± 0.006</td>
<td>- 0.042 ± 0.003</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>- 0.033 ± 0.002</td>
<td>- 0.061 ± 0.006</td>
</tr>
<tr>
<td>1 w – 12 m</td>
<td>(1)</td>
<td>- 0.054 ± 0.004</td>
<td>- 0.079 ± 0.005</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>- 0.067 ± 0.006</td>
<td>- 0.081 ± 0.007</td>
</tr>
<tr>
<td>1 w – 24 m</td>
<td>(1)</td>
<td>- 0.105 ± 0.009</td>
<td>- 0.134 ± 0.005</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>- 0.109 ± 0.004</td>
<td>- 0.176 ± 0.031</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effects</th>
<th>P. value ≠</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>&lt; 0.001</td>
<td>Yes</td>
</tr>
<tr>
<td>Time</td>
<td>&lt; 0.001</td>
<td>Yes</td>
</tr>
<tr>
<td>Line</td>
<td>&lt; 0.001</td>
<td>Yes</td>
</tr>
<tr>
<td>Time / group interaction</td>
<td>&lt; 0.001</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Values are mean difference ± standard deviation (MD ± SD)
≠ P. value ≤ 0.05 is considered significant.
Change in the height of the residual ridge

Table (2), demonstrates the mean difference and standard deviation at the two vertical lines located on the residual ridge for both groups. The gained values showed no statistical significant difference between the right and left side of residual ridge in both groups. More ridge resorption was identified in relation to the vertical posterior line than the anterior line by time in all groups. Statistical difference was found between lines (P < 0.001) and from one interval to the other (P < 0.001).

Statistically, it was found that the decrease in ridge height with respect to the OT REVERSE /3 group was significantly more than the ZAAG group at each interval (P < 0.001).

There was a significant change in ridge height for all groups, at each time interval. Moreover, for all times, a significant change between all groups occurred (P < 0.001).

Maintenance Complications

A variety of maintenance complications were noted during the 2-year study period (Table 3). During the first year, more percentage of complications was registered in the ZAAG group compared to the OT REVERSE /3 group. In the second year of follow-up these percentages decreased. In the ZAAG group, a total of 28 complications were registered during the 2-year observation period with a mean of 4.6 complications per patient yearly. The most frequent complication was the nylon cap wear and replacement. In the OT REVERSE /3 group, a total of 20 complications were registered during the 2-year follow-up with a mean of 3.3 complications per patient yearly. The most extensive complications were overdenture border correction and denture reline.

### TABLE (3) The frequencies and percentage of the maintenance complications among the two groups at different follow-up periods.

<table>
<thead>
<tr>
<th>Complications</th>
<th>ZAAG = 6 (n)</th>
<th></th>
<th>OT REVERSE/ 3 = 6(n)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 n</td>
<td>12 n</td>
<td>24 n</td>
<td>6 n</td>
</tr>
<tr>
<td>- Nylon cap wear and replacement</td>
<td>3 (50)</td>
<td>5 (83.3)</td>
<td>0</td>
<td>1 (16.7)</td>
</tr>
<tr>
<td>- Overdenture fracture or remade</td>
<td>0</td>
<td>1 (16.7)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>- Correction of overdenture border</td>
<td>3 (50)</td>
<td>1 (16.7)</td>
<td>1 (16.7)</td>
<td>3 (50)</td>
</tr>
<tr>
<td>- Overdenture reline</td>
<td>0</td>
<td>1 (16.7)</td>
<td>2 (33.3)</td>
<td>1 (16.7)</td>
</tr>
<tr>
<td>- Maxillary denture reline</td>
<td>0</td>
<td>1 (16.7)</td>
<td>3 (50)</td>
<td>0</td>
</tr>
<tr>
<td>- Minor occlusal adjustments</td>
<td>1 (16.7)</td>
<td>2 (33.3)</td>
<td>1 (16.7)</td>
<td>1 (16.7)</td>
</tr>
</tbody>
</table>

Values = frequency (percent).
An implant-supported mandibular overdenture with only two implants is a simple treatment in edentulous subjects. The number of implants to support the overdenture may be restricted to two, as the number has been shown to be of minor importance for the treatment outcome (27).

Attachments used with a minimal number of implants are dependent on the denture-bearing capacity of the soft tissue and the relative movements that may be allowed by differential support. These attachments should be durable and easily replaced. They may exhibit increased wear, resilience and mobility because of greater reliance on soft tissue support (28).

There are occasions when remaining interarch distance would dictate the use of very short attachments (29). Several methods were carried out to estimate the height and width of this space (15, 17, 30, 31). Early detection of space limitation problems over the anticipated implant positions allows for the selection of the appropriate attachment. Problems such as fractured or over contoured prosthesis may occur because of inappropriate planning. This can result in the need for replacement of the implant overdenture attachment, late modification of the treatment plane or even failure of the definitive prosthesis (31).

Titanium attachments [OT REVERSE/3] (Fig. 5,9), the spherical shaped male sectioned longitudinally produces the retention and functions by taking advantage of the elasticity of the metal. The mechanical behavior is that of a spring constructed in the shape of a “u”. The retentive component (male) is oversized with respect to the female. The pressure necessary to insert the prosthesis activates the elastic mechanism; the sphere retracts up until it passes the opening of the female component, which finds an ample space inside allowing spherical movement. The “male”, thanks to the elastic memory of the titanium, produces retention at the equator of the sphere. The nylon that incorporates the titanium spring also contributes to the functionality over a period of time.

The elasticity permits the “male” to be inclined slightly in all directions. The form of the “female” component of the attachments, with the center of gravity lowered to the level of the gingival level, assists solving in many cases the problem of narrow interarch space.

The majority of the bone loss adjacent to endosseous implants supporting complete mandibular overdentures occurs during healing and remodeling periods (32,34). Goodacre et al (35), reported that the mean marginal bone loss that occurs during the first year was 0.9 mm (range from 0.4 to 1.6 mm). The mean loss per year in subsequent years was 0.1 mm (range from 0 to 0.2 mm).

Both ZAAG and OT REVERSE /3 attachment systems are classified as “universal hing” resilient attachments for endosseous implants. The fact that both attachments resulted in significant increase in bone loss through out all follow-up intervals in this study, could be attributed to the intraradicular design, in which the key way component is positioned more apically into the implant abutment and closer to the alveolar ridge leading to higher forces and moments.

Porter et al (36), reported that the largest implant forces and highest moments existed with the ZAAG attachments. Being provided with high retentive force, ZAAG attachments was used as a non-mobile control for the resilient sleeve rings. Hence, it could be concluded that when the retention of the stud attachments increases, the amount of forces and moments applied on the implant and its supporting structures increases (22).

OT REVERSE / 3 group showed a significant decrease in the amount of bone loss throughout all intervals relative to the ZAAG group. The decrease might be attributed to the different degree of stiffness of the actual nylon components of the 2 systems.

Moreover, the location of the nylon component being intraradicular in the ZAAG attachment sandwiched between the male sphere and the metal cap in the OT REVERSE / 3 attachment, may lead to a decrease in the magnitude of forces reaching to the implant abutments and hence to the crestal supporting bone. The location
of the nylon cap in the OT REVERSE /3 attachment facilitates the movement of the prosthesis according to the direction of the applied load, dissipating partly the resultant forces before it reaches the implant and its supporting structure.

More vertical ridge resorption is normally recorded when going further apart from the implants supporting mandibular overdenture. This statement supports the increase in the amount of bone loss in the residual ridge height at line two than one in this study. Masticatory forces applied to the posterior teeth result in displacement of mucosa and rotation of the prosthesis, which results primarily in pressure on the posterior mandible (37).

Resilient overdenture design guarantees free rotation during dorsal loading, with twist-free load transmission to the implants in a nearly axial direction (38). The movable retention mechanism in the OT REVERSE/3 attachments is seen to possibly protect against implant overloading (stress-breaking function) because of more force transmission to posterior mandibular bone (20, 39).

The male portion, being free to swivel after its introduction in its female compartment, the OT REVERSE / 3 attachment transmits low forces in the vertical and buccolingual direction. The transverse and horizontal forces may reach triple the amount of the vertical load(40). This leads to the assumption that vertical chewing forces acting on the overdenture were transmitted to high extend to the residual ridges than to the implants. Hence, an anchorage system that provides for more vertical loading is more desirable. This may be a favorable factor regarding the long-term loading of implants. It is generally assumed that horizontal forces directed to the implants should be avoided to prevent bone resorption or angular defects. The increased retention of ZAAG attachment may provide this type of force (40).

Walton and Mac Entee (41) in a retrospective study gathered the problems faced with overdenture prosthesis on implants. They deduced that the vast majority of repairs were needed with the first year of service. It was mainly related to alternation of contour and repair of matrix or patrix (42).

ZAAG nylon male fits tightly when new and seems to allow little room for resiliency. Movement is in the form of mortar and pestel. Moreover, the spherical shape nylon has retention only at the height of contour against a rough internal surface of the female inducing fast wear problems. When the nylon part is exposed to the oral fluids, it is progressively subjected to wear, allowing a greater freedom on motion (29, 43- 45). In the present study, when the retention of the mandibular overdenture was largely decreased the nylon parts were exchanged aiming to the preservation of denture stability.

It was observed that in ZAAG attachment group, patients were not able to adapt easily with denture insertion and removal, as the male portion is liable to bending during seating leading to its replacement. In the OT REVERSE / 3 attachment, constructing the “male” in titanium with a design that made it particularly elastic and robust, functionality and resistance are assured even in cases when it is improperly inserted. Plastic “male” attachment is used as a temporary retention after cutting the shaft. In this case the patients are trained until they are able to carefully insert the prosthesis with precision.

Patients with maxillary dentures undergo a 4 % vertical bone loss in the anterior maxilla opposing mandibular implant supported overdentures compared with 13% for those opposing conventional mandibular dentures(46). This finding was attributed to increased instability of the conventional mandibular dentures, which caused unfavorable stress distribution to the opposing arch (47).

Restoring the anterior teeth with no contacts in maximum intercuspation and providing posterior contacts in eccentric occlusion may have minimized loading the edentulous anterior bone loss (48).

Relines of maxillary complete dentures and mandibular overdentures were required most commonly after 16 months of service. Patients generally seek improved stability and retention of the maxillary denture after accommodating to highly retentive implant-retained mandibular prosthesis (12).
CONCLUSIONS

Under the condition of this 2-year study the following conclusions were drawn:

- The OT REVERSE / 3 attachments might be selected over the ZAAG attachment when designing a 2-implant retained mandibular overdentures in solving the problem of narrow interarch space.
- The OT REVERSE / 3 attachments provide less amount of bone loss levels around the implants.
- More masticatory load is transmitted to the implants and less to the denture-bearing area when the ZAAG attachments were used and vise versa when the OT REVERSE / 3 attachments were used.
- During the first year of function, more maintenance complications were registered.
- The most common prosthodontic complications reported were wear and replacement of nylon male with respect to the ZAAG attachment group and denture reline with respect to the OT REVERSE / 3 attachment group.

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