**ABSTRACT**

*MANDIBULAR IMPLANT-RETAINED OVERDENTURE (IOD) is an especially attractive treatment because of its relative simplicity, minimal invasiveness and economy. The high activity in applying immediate/early loading protocols is indicated by an increasing number of publications and conference abstracts. Splinting of immediately loaded implants by a bar, prevent micromovement and hence improve osseointegration in addition to improvement of overdenture retention. Recently, pre-fabricated bars can be placed directly on immediately loaded implants to retain mandibular overdenture.*

This study was aimed to evaluate the bone height changes around immediately loaded implants splinted with pre-fabricated bar to retain mandibular overdenture.

Six completely edentulous healthy males were selected for this study. For each patient, two standardized size; of 13 mm length and 3.6 mm width; screw-type implants were surgically inserted in the canine areas and splinted with pre-fabricated bar to retain immediately loaded mandibular overdenture.

Along the first and second six months after overdenture insertion, the bone height changes were evaluated radiographically to measure the peri-implant marginal bone loss and the results were statistically analyzed.

Within the limitations of this study, it can be concluded that splinting of immediately loaded implants with prefabricated bar attachment to retain mandibular implant overdenture can be considered as a successful prosthetic approach for preserving the peri-implant marginal alveolar bone.
INTRODUCTION

Among different treatment options, an implant-retained overdenture is a simple, cost-effective solution in the rehabilitation of the edentulous mandible (Alexander et al. 2007).

Many studies revealed that a mandibular implant retained overdenture (IOD) is an effective form of treatment especially for the edentulous mandible (De Grandmont et al. 1994, Burns et al., 1995 and Al-Omari et al. 2005).

Overdenture retained by two interforaminal implants has been advocated as the first choice for treatment of the edentulous mandible (Feine et al. 2002 and Peterson et al. 2003. Naert et al. (2004) concluded that the implant-retained overdenture supported by two implants in the mandible had a 100% success rate.

The surgical protocols needed for placement of these implants can be classified into: (a) Two-stage surgical protocol, (b) One-stage surgical protocol (Misch et al., 2004). One-stage surgical protocol imposes less psychological and physical trauma to the patient, decreases the cost, and saves the chair-time of the clinician (Chee and Jivraj, 2003 and Testori et al., 2004).

It was agreed that any reduction in osseointegration period prior to implants being loaded with the definitive overdenture is welcomed by both clinicians and patients as dentures are constructed in shorter period of time (Aparicio et al., 2003).

Attard and Zarb (2005) summarized the overdenture loading protocols; other than the delayed loading protocol; into early progressive loading, early functional loading and immediate-early functional loading.

In immediate-early functional loading, the retentive attachments were connected within five days. Some authors used the bar-clip assembly in their studies (Chiapasco et al., 2001; Gatti et al., 2000; Babbush et al., 1986; Romeo et al., 2002 and Rungcharassaeng et al., 2002).

Recent studies demonstrated that with the evolution of new implant designs, precise control of the surgical protocol in one-stage and immediate loading, the results were significantly similar with the delayed loading (Ledermann, 1998, Randow et al. and 1999 Di Bernardo, 2001 and Linkow and Miller, 2004).

The ultimate goal of an immediate loading protocol is to reduce the number of surgical interventions, shortens the time frame between surgery and prosthesis delivery without compromising the success rate of the procedures, reduces cost of treatment and minimizes surgical trauma. So, the new protocols lessen patients’ reservations, resulting in increased acceptance and satisfaction of implant therapy (Colomina, 2001; Chee and Jivraj, 2003; Hatano et al, 2003 and Testori et al, 2004).

Despite widespread acceptance of implant-retained overdentures, some controversies still exist with regard to the design of the overdenture, selection of the appropriate attachment system, and the most optimal techniques for the overdenture fabrication (Alexander et al. 2007)

The attachments that are used for connecting (IODs) to underlying implants can be classified as ball and O-ring, bar(s) and clip(s), magnets, resilient denture liners, and other types of mechanical attachments (Kiat-Amnuay et al., 1999, Payne and Solomons, 2000, and Davarpanah et al., 2003, Tokuhisa et al., 2003, Fanuscu and Caputo, 2004, Naert et al. 2004 and MacEntee et al. 2005).

Bar-and-clip attachments have been advocated for splinting the implants and connecting the prosthesis to them (Sadig, 2003 and Hobkirk et al., 2003).

Splinting of implants by a bar was thought to prevent micromovement and hence improve osseointegration (Naert et al., 1994, Menicucci et al., 1998, Gatti et al, 2001 and Romeo et al., 2002).

The overdenture bars may be cemented or screw-retained. Cement-retained frameworks are purported to fit more passively, some implant manufacturers indicated

Recently, pre-fabricated instant adjusting bar adds a new dimension to the prosthetic constructions of bar-connected overdentures in implantology. It can be placed directly and without any tension on every pair of (none) parallel implants. It adjusts itself automatically, fully stress-free to the implant up to an angulation of 18°, when threading the fixation screws. The idea of adjustable bar connection is based on a simple joint-like system. The laboratory can immediately make the complete superstructure with the retention parts without the need of several visits of the patient for verifying the fit of the bar construction. This system substantially reduces time and costs for the dentist, dental technician and the patient (Biesaga, 2004).

This study aimed to evaluate the bone height changes around immediately loaded implants splinted with the pre-fabricated instant adjusting bar to retain mandibular overdenture.

**MATERIAL AND METHODS**

Six healthy male patients of 45-60 years old were selected for this study. In all patients total edentulism of maxilla and mandible was at least six months before implant placement. All patients were of Angle’s class I maxillomandibular relations.

A minimum interarch distance of 20 mm at the canine area was selected. TMJ disorders, abnormal detrimental habits, and history of radiation therapy in the head and neck region were exclusion criteria.

Patient’s general condition including blood pressure, pulse rate and respiratory rate were evaluated by a physician. Also, laboratory investigations were performed including complete blood picture and blood glucose level.

Preoperative digital panoramic radiograph was taken to evaluate the bone quality and quantity in the mandibular canine area. The residual ridges were healthy and showed normal bony trabecular pattern. The radiographic ridge height was measured in the canine areas from the crest of the ridge to the inferior border of the mandible. The average height was $21 \pm 3$ mm. The width of the ridge was clinically measured in the canine area of all cases by using osteometer. The width ranged from 4.5-5 mm.

For all patients, preliminary impressions of the maxilla and mandible with irreversible hydrocolloid* were made to serve as a guide for fabrication of custom acrylic resin** impression trays.

After border molding of the tray with modeling compound***, maxillary and mandibular final rubber base impressions**** were made. The maxillary cast was mounted on an articulator***** using face-bow****** and the mandibular cast was mounted using interocclusal records.

Monoplane acrylic resin teeth******* were selected and arranged, then the waxing was completed in a conventional manner.

---

* CA 37; Cavex Holland BV, Haarlem, The Netherlands
** Meliodent; Heraus Kulzer, Dormagen, Germany
*** Impression Compound; Kerr Italia S.p.A., Salerno, Italy
****Speedex; Coltene/ Whaledent, Altstetten, Switzerland
*****Dentatus international, ARLS, Hagersten
******AB Dentatus, Stockholm
*******Major, Dental Industry, Monocolieri, Ital
The completed denture teeth arrangement was evaluated intraorally and examined for esthetics, speech, and functional fit. Necessary adjustments were completed, and then the dentures were repositioned on the final casts and processed into heat-cured acrylic resin*. After finishing and polishing, dentures were laboratory remounted to adjust premature occlusal contacts (Misch, 2005).

The mandibular complete denture was prepared to be used as a surgical template for inserting two interforaminal implants. Labial and lingual lines were drawn parallel to the long axis of canines. These lines were extended to meet each other in the denture fitting surface in the canine areas. 3 mm wide guidance-holes were drilled to provide guidance for the pilot drill placement.

Under local anesthesia, two standardized size; of 13 mm length and 3.6 mm width; Acid-etched Roughened Titanium (ART) screw-type implant** were surgically inserted in the canine areas of each patient and the healing abutments were screwed into their fixtures (Fig.1).

Postoperative digital panoramic radiograph was taken to evaluate the position of fixtures in bone (Fig.2).

Fig. (1) Healing abutments screwed in to their fixtures.

Fig. (2) Postoperative digital panoramic radiograph.

The fitting surface of the mandibular denture was relieved to provide adequate space to fit over the healing abutments without rocking. The denture was relined with tissue conditioner. The patient was administrated 1 gm Amoxycillin Tab. and 50 mg Declophenac Tab. twice daily. Antiseptic mouth wash was used and the patient was instructed for home care and soft diet.

After 5 days, sutures were removed and transfer copings were connected to the implants intraorally (Fig.3).

Fig. (3) The transfer copings connected to their implants.

---

* Mollodent, Bayer, Leverkusen, W. Germany

** Dyna Dental Engineering bv, 4600 AB Bergen op Zoom, Netherlands.
Two holes of 6 mm diameter were perforated in the canine areas of autopolymerized acrylic resin custom tray (constructed on the mandibular diagnostic cast) to provide adequate spaces for the transfer copings.

After border molding with green stick compound, final rubber base impression was made with the opened tray technique (Fig. 4).

The implant analogs (Dyna Dental Engineering bv, 4600 AB Bergen op Zoom, Netherlands) were threaded into the impression posts before pouring the impression into hard stone to fabricate the final cast (Fig. 5).

The bar abutments were screwed into the fixture analogs with the single slot screwdriver. The pre-fabricated Instant Adjusting Bar (IAB)* was used. It consists of the following parts:

- Bar Joint (arm Ø 1.9 mm)
- Bar extension abutments (available in different transgingival lengths).
- Round shaped bar.
- Universal Dyna fixation screws.
- Bar Riders.

The bar was adjusted on the model according to the manufacturer instructions (Biesaga, 2004) (Fig. 6).

The bar was disassembled from the cast and the healing abutments were replaced by the bar abutments to secure the bar assembly into position in patient’s mouth (Fig. 7) using the single slot screwdriver and the Dyna torque wrench to 35Ncm.

The IAB was checked intraorally for stress-free fit then the bar abutment were repositioned to the master cast for final construction of the bar-joint mandibular overdenture. A metal spacer of 1mm thickness was inserted between the bar and its retentive riders (one

---

* IAB, Dyna Dental Engineering bv, 4600 AB Bergen op Zoom, Netherlands
on each side of the bar). According to Sadig, 2003, all undercuts gingival to the riders and the greatest contour of the bar were blocked out. A sheet of wax spacer (2mm thickness) was adapted on the entire surface of the bar abutment assembly, the retentive riders were left exposed. The cast was duplicated and poured with extra-hard dental stone.

After jaw relation records, mounting, arrangement of monoplane acrylic teeth, try in, the waxed up overdentures were processed into heat-cured acrylic resin. Finishing and polishing were done (Fig. 8), and the overdentures were laboratory remounted to adjust premature occlusal contacts.

The healing abutments were replaced by the bar abutments and the bar assembly was secured into position. The patients were instructed for proper oral hygiene, including brushing of dentures and the bar abutments and regular using of mouth rinses.

For each patient, Digital panoramic radiographs were taken just before, 6& 12 months after loading with the final overdenture using the same machine, the same position of the patient and the automatic processor for standardization of contrast of the radiographs. Using the Corel Draw software, the digital panoramic image was analyzed to measure the mesial and distal vertical marginal bone loss for each implant. To eliminate the radiographic magnification error, the radiographic fixture size was corrected by the Corel Draw software to its true length and width. Reference lines and points were identified to measure the implant marginal bone loss as in (Fig. 9).

![Fig. (7) The bar assembly secured into position in patient’s mouth.](image)

![Fig. (8) The retentive riders in the fitting surface of the finished mandibular overdenture.](image)

![Fig. (9) Reference points and lines used to measure implant vertical marginal bone loss](image)

The mean of mesial and distal vertical distance was measured and calculated as follows:

\[
\frac{AA' + BB'}{2}
\]

Along the first and second six months after overdenture insertion, the mean vertical bone loss was measured and calculated and the results were statistically analyzed.
RESULTS

Table (1) shows that the mean marginal bone loss (mm) along the first and second six and 12 months after mandibular overdenture insertion was 0.66±.107, .45±.08 and 1.11± .14 respectively. It was found to be statistically significant \( (t=21.253, 18.517 \text{and } 26.384 \text{ respectively and } p<.01)\).

<table>
<thead>
<tr>
<th>TABLE (1) The mean peri-implant marginal bone loss (mm) along the first and second six and 12 months after mandibular overdenture insertion:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Along first 6 months</td>
</tr>
<tr>
<td>( \bar{X} )</td>
</tr>
<tr>
<td>X’</td>
</tr>
<tr>
<td>S.D.</td>
</tr>
<tr>
<td>t</td>
</tr>
<tr>
<td>p</td>
</tr>
</tbody>
</table>

n= 12  \( \bar{X} \)= Arithmetic mean  S.D. =Standard deviation  * significant \( (p \leq .01) \)

Table (2) shows the comparison between the means of marginal bone loss along the first and second intervals of study. Comparing the means of peri-implant marginal bone loss along the first and second six months was found to be statistically significant where \( t = 5.931 \) and \( p <.01 \).

<table>
<thead>
<tr>
<th>Tab. (2): Comparison between the mean peri-implant marginal bone loss along the first and second intervals of study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The mean marginal bone loss  ( X’ )  S.D.  df  t  P</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>0.2125 0.1241 11 5.931* &lt;.01</td>
</tr>
</tbody>
</table>

\( df=n-1 \)  \( \bar{X} \)= Arithmetic mean  S.D. =Standard deviation  * significant \( (p < .01) \)

DISCUSSION

The implant long term serviceability is a major goal for implant prosthodontics. However, earlier delivery of the final superstructure is also a major demand for completely edentulous patient. Since the immediate loading concept may offer this, it would be logic to select the immediate loading protocol that can provide both requirements. This work is aimed to evaluate the tissue health changes around immediately loaded implants splinted with pre-fabricated bar used to retain mandibular overdenture.

The mandibular arch was selected for implant placement because problems encountered with denture retention and stability were often associated with the mandibular conventional complete denture (Tahaniri and Tiong, 1998 and Meijer et al., 2004).

Two interforaminal immediately loaded implants were used because the survival rate of two interforaminal implants used to support overdenture reached 100% in many studies (Payne et al., 2001, Payne et al, 2002, Roynesdal et al, 2001 and Tawse-Smith et al., 2002).

Male patients were selected for this study to avoid the possibility of osteoprotic changes in the jaw bones which are commonly observed in post menopausal women. These changes may impair the integration process and increase the implant marginal bone loss (August et al., 2001).

All patients were healthy and free from systemic diseases that might affect the jaw bone quality and the crestal bone loss. Fiorellini et al. (2002) observed altered bone and mineral metabolism possibly interfering with the integration process in diabetic patients. Cranin (1991) reported that the long term use of corticosteroids generates a systemic loss of bone mass, delayed wound healing and modify a patient’s response to bacterial infection. Curtis (1996) found that chemotherapy treatment causes malnutrition of osseous tissue, xerostomia and mucosal inflammation.
The residual ridges were healthy and showed normal bony trabecular pattern to allow suitable chance for successful osseointegration. Wood and Vermilyea (2004) pointed out that there must be proper quantity and quality of bone into which dental implants are placed. The presence of too much loose trabecular bone pattern may limit early stability of an implant and may also require a longer integration time.

Patients were selected of Angle’s class I maxillo-mandibular relations to minimize the harmful stresses transmitted to the implant by Angl’s class II & III (Misch, 2005).

Patients with a minimum interarch distance of 20 mm at the canine area were selected for this study to provide enough space for placement of the implant attachments and the superstructures. This was supported by De Boer (1993) who found that adequate space for overdenture must exist to ensure that there is a room for the abutments and esthetic arrangements of the artificial teeth. Rungcharassaeng and Katz (2000) stated that the minimum clearance between the top of the implant fixtures and the tissue surface of the overdenture is 7 mm for the bar placement. Also, Peterson et al. (2003) and Davarpanah et al. (2003) mentioned that there must be adequate interarch space to accommodate for the attachment.

Patients were free from abnormal detrimental habits such as clenching and bruxism because they are associated with increased pressure on the implants and results in surrounding bone loss (Manz, 2000, Colomina, 2001, and Isidor, 2006).

A standardized implant size was selected for all patients to eliminate the effect of the implant surface area on the integration process or the implant marginal bone. A 3.6 mm. implant width was selected because the average width of the alveolar ridge crest measured in this study was 4.5-5 mm. Misch (2005) recommended that a minimum of 0.5 mm. bone should exist on each side of the implant at the crest of the ridge to ensure sufficient available bone thickness and blood supply around the implant for predictable survival. Also, 13 mm. implant length was selected in this study to maximize the implant anchorage in the bone which is strongly recommended for the early loading phase. The longer is the implant, the longer the bone to implant surface area and the successful integration (Wood and Vermilyea, 2004). A minimum of 9 mm. bone height in the anterior of the mandible is recommended for a predictable long term implant survival (Misch, 2005). Rissolo and Bennett (1998) reported that the alveolar ridge width must be sufficient to permit 1.5 mm of bone in both the labial and lingual surfaces for circumferential osteogenesis.

Monoplane acrylic resin teeth were arranged for balanced centric and eccentric occlusal contacts to eliminate the lateral or horizontal occlusal forces being transmitted to the implants during function. Such forces magnify the amount of tension and shear to the implant crestal bone and increase the risk of marginal bone loss (Misch, 2005).

Digital image processing was used to measure the implant marginal bone loss. Heckman et al., 2004, reported that this method is reliable and achieves a high degree of precision than the visual metric method.

The results of this study revealed that the peri-implant marginal bone loss were less than 1.2 mm after 12 months of overdenture insertion.

This finding may reveal that all implants exhibited better initial stability that may be enhanced by the splint effect of the used prefabricated stress-free bar. It was suggested that immediately loading implants should be splinted together with a bar within a short period of time to prevent axial rotation and implant micromotion and hence improve osseointegration (Naert et al., 1994, Menicucci et al., 1998, Gatti et al, 2000 and Romeo et al., 2002).

Meijer et al. (2004) stated that micromotion can lead to disruption of the bone-cell/implant contacts and has
the ability to disturb the cell reaction by a detachment; or micromotion can lead to deformation of osteoblasts fixed at the surface of the implant.

Also the passive fit of the used prefabricated bar attachment in this study (Biesaga, 2004) may aid in evenly and widely distribution of the functional stresses along the implants. Preiskel, 1996 and Misch, 1998 stated that, if screw-retained bars are used, a passive fit of the framework is the primary objective to accomplish a balanced distribution of the masticatory forces.

**CONCLUSION**

1. Splinting of immediately loaded implants with prefabricated bar attachment to retain mandibular implant overdenture can be considered as a successful prosthetic approach for preserving the peri-implant marginal alveolar bone.

2. The use of pre-fabricated bar to retain mandibular implant overdenture may be a promising treatment for completely edentulous patients.

**REFERENCES**


