Maintenance Requirements Associated With Mandibular Implant Overdentures: Clinical Results After First Year of Service

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The aim of this clinical study was to evaluate the prosthodontic maintenance requirements during the first year of service of mandibular overdentures supported by interforaminal implants and to assess the influence of attachment type, implant number, and bite force on these requirements. Fifty-nine patients treated with mandibular implant overdentures between the years 2004 and 2009 and appearing in the 12th-month recall were included in this study. The overdentures constituted 4 groups: 2 single interforaminal implants (1 group with locator and 1 group with ball attachments), 3 single interforaminal implants, 3 splinted interforaminal implants (bar), and 4 splinted interforaminal implants (bar). During the examination, prosthetic parameters such as occlusion, tissue adaptation, condition of the retentive mechanism (matrice and patrice), and the condition of the denture-bearing tissues were evaluated and recorded. No statistically significant relation was found between attachment type, bite force values, implant number, and the occurring complications except the need for relining, which was found significantly more in the ball attachments than in other attachment groups ($P = .03$). After 12 months following the overdenture insertion, there seems to be no relation between occurring complications and patient-related factors, such as maximum bite force, age, and gender, as well as factors related to the overdentures such as number and type of attachments.

Key Words: mandibular overdenture, screw loosening, loss of retention, relining

INTRODUCTION

Mandibular implant overdentures (OVDs) offer an effective rehabilitative treatment for edentulous patients.\textsuperscript{1–3} Generally, the implants that are assumed to achieve a good retention and stability for the planned OVDs are placed interforaminal for anatomical and surgical reasons, thus offering the patient a higher satisfaction and quality of life.\textsuperscript{4,5} However, it is well known that implant-retained OVDs require routine maintenance and periodic repairs, since the denture-supporting implants are subject to biomechanical forces.\textsuperscript{6–13} Controversy exists about the force transmission of single or splinted attachments.\textsuperscript{10–13} Although some studies suggest that when loaded, splinted implants act together as a group instead of single units and protect the implants\textsuperscript{14,15} and that bar
retention is a solution with least complications and repairs, there are authors pointing out the danger of mismatch of deformations between the mandible and a rigid single continuous bar, which could lead to bone loss around the supporting implants, material fracture, or screw loosening due to stress accumulation.

Even though little is known about the influence of the number of implants on generated stresses, retention and stability are believed to be better with more implants. Although there are a few clinical reports, the effect of the number and distribution of implants on the stresses is an even less investigated issue.

In fact, in the interforaminal region where the overdenture-supporting implants are positioned, the flexure could have a more significant effect than in the posterior mandible. A bar fixation, which is more rigid than the bony tissue, would not follow the flexure and thus generate stress. On the other hand, in several clinical follow-up studies evaluating edentulous patients with 2 interforaminal implants, the retention mechanism of mandibular implants supporting an OVD was found to have no influence on the marginal bone level maintenance and clinical parameters; thus, this assumption was not supported.

Although there are numerous studies reporting several implant- and denture-related complications, obviously there is a lack of knowledge on the influence of implant number and attachment type on time-dependent need of OVD repairs.

This study was planned to evaluate the relation between implant number, attachment type, and maximum bite force on occurring complications in mandibular OVDs.

**Materials and Methods**

**Patient recruitment and clinical procedures**

Fifty-nine patients (20 male [33.9%] and 39 female [66.1%]) with an average age of 63.83 ± 10.10 (range, 42–90 years) with mandibular implant OVDs treated between the years 2004 and 2009 and appearing in the 12th-month recall were included in this study. Informed written consent with regard to treatment and measurement procedures was given by the patients involved, and approval from the ethics commission was duly obtained. The patients’ OVDs constituted 4 groups: 2 single interforaminal implants (1 group with Zest Anchor locator and 1 group with ball attachments), 3 single interforaminal implants, 3 splinted interforaminal implants (bar), and 4 splinted interforaminal implants (bar). All patients included in the study had been maxillary edentulous full denture wearers.

At the recall session, a clinical examination was performed by the same 2 examiners. During the examination, prosthetic parameters such as occlusion, tissue adaptation, condition of the retentive mechanism (matrix and patrice), and the condition of the denture-bearing tissues were evaluated. While the condition of the denture-bearing tissues was inspected, the adaptation of the dentures was checked using a pressure indication paste, which was prepared chairside with a mixture of 1 g zinc oxide ointment (White Impression Paste, S.S. White Manufacturing, Glouchester, England) and 1 g petroleum jelly. Pressure spots were eliminated by grinding from inside the denture base. If the denture base adaptation was not acceptable, a relining was performed. Occlusion was checked for premature contacts, which could have arisen due to wear and eliminated. In case of loosening of abutment or occlusal screws, these were tightened up. Loosened retentive mechanisms were either changed or tightened. In case of loss of retention, the matrices in the dentures were changed. The patrices were checked for the presence of an eventual wear and changed if necessary.

All required corrections and repairs were recorded. The maintenance required for each
overdenture was recorded either as an adjustment or a repair. Adjustment indicated a modification that did not add new material to the existing overdenture or replace broken or missing components such as correction of occlusion, tightening of abutment screws, or correcting the underlying cause of traumatic ulcerations, whereas repair indicated the addition or replacement of material or teeth.

**Statistical analyses**

Statistical analyses were used in this study to assess the potential effect of various parameters on the maximum bite forces. For the statistical analysis of the results, the Number Cruncher Statistical System (NCSS, 2007) and PASS 2008 statistical software (Kaysville, Utah) were used. Demographic parameters (age and gender), prosthetic options (bar, locator, or ball attachment), and number of implants was evaluated. Beside descriptive statistics (means and standard deviations), the comparison of quantitative data was accomplished with the 1-way analysis of variance test for the comparison of groups with normal distribution, whereas the comparison of qualitative data was done with the $\chi^2$ test. The results were assessed at the 95% confidence interval, at a significance level of .05.

**RESULTS**

Fifty-nine mandibular implant-supported OVD patients (20 male [33.9%] and 39 [66.1%] female) with an average age of 63.83 ± 10.10 years (range, 42–90 years) appearing in the 12th-month recall were included in the study.

The distribution of prosthetic complications is shown in Table 1.

While in more than one-third of all patients (n = 20; 33.9%) no complications were detected, in nearly two-thirds of the patients (n = 39; 66.1%) 1 or more complications could be recorded. Nineteen of 39 patients showed the need for only one type of adjustment or repair, whereas in 20 patients, the combination of several types of adjustments or repairs had been necessary. The most frequent observed single complications were the following:

1. Loss of retention: n = 6 (10.2%)
2. Fracture of denture base: n = 5 (8.5%)
3. Pressure spots (ulceration): n = 5 (8.5%)
4. Dislodged attachment clip: n = 4 (6.8%)
5. Screw loosening: n = 2 (3.4%)
6. Need of occlusal adjustment: n = 1 (1.7%)

The need for relining was observed in 10 patients but only in combination with other complications and significantly higher in ball attachments ($P = .30$).

There was no statistically significant relation between attachment type (Table 2), age ($P = .890$) or gender ($P = .428$) of patients, maximum bite force values ($P = .837$), or number of implants (Table 3) and the occurring complications and complication types ($P > .05$).

When evaluated particularly, the bar clip retention showed significantly less complications, especially less need of relining of the mandibular OVD ($P = .03$; Table 2).

**DISCUSSION**

It is of great importance for the clinician to know what complications may occur during the use of implant OVDs in order to choose the treatment that requires least maintenance.

Studies have shown that technical problems occur both during the first year after treatment and in the long term, whereas it was reported that the frequency of technical problems decreases over time.\(^{25–28}\) Taking this opinion into consideration, the evaluation of the first-year complications of mandibular implant OVDs is demonstrative for overall maintenance requirements. The most frequent complications related to mandibular implant OVDs that have been reported in the literature are loss of retention or damage...
to the retention mechanism,\textsuperscript{22,29–34} fractures of the restorative material,\textsuperscript{29–32,35–39} and need of rebasing or relining.\textsuperscript{3,22,29,31–33,35,36,38}

There is an ongoing debate about the influence of attachment type on later technical complications in implant OVDs, although only a few studies have compared treatment outcomes with different attachment devices of OVDs. As an example, a comparative study on different connection systems (splinted vs unsplinted) found that single attachments provide lower retention than do bars for fixation of OVDs, but the long-term complication outcome was not mentioned.\textsuperscript{34}

It is well recognized that attachments of OVDs on implants lose retention after some time. Fatigue and wear of the material could be another factor causing complications with retention loss.\textsuperscript{40} Several clinical measurements proved that 3-dimensional loads occur regularly during function. A denture may rotate around an anterior bar, or it may rock slightly, when food is chewed on 1 free-end denture base. These movements can clinically lead to plastic deformation of the matrix, resulting in a reduction of retention or dislodgement of the clip.

In some publications in the past decade, there was an agreement about no observable effect of the attachment design on the incidence of maintenance requirements.\textsuperscript{41} Although there is no unanimous opinion, several authors have reported that prosthodontic maintenance requirements with ball attachments were higher,\textsuperscript{42–44} particularly during the first year.\textsuperscript{30} The review by Cehreli et al\textsuperscript{45} pointed out that a dislodged, worn, or loose matrix or its respective housing was more common after the first year with ball retainers and the most common repair was retentive component replacement. The results of a study by Dudic and Menticke-Stern\textsuperscript{13} focused mainly on the comparison of the retention mechanism complications. Broken, loose, or lost bar clips and female retainers of ball anchors had been significantly more often detected with resilient attachments, whereas the rigid bar required significantly more retightening of the female

\begin{table}
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\begin{tabular}{|l|c|}
\hline
Complication & n & \% \\
\hline
None & 20 & 33.9 \\
Necessity of occlusal adjustment & 1 & 1.7 \\
Ulceration & 5 & 8.5 \\
Dislodged attachment clip & 4 & 6.8 \\
Loss of retention & 6 & 10.2 \\
Fracture of denture base & 5 & 8.5 \\
Screw loosening & 2 & 3.4 \\
Necessity of relining + loss of retention & 2 & 3.4 \\
Necessity of occlusal adjustment + ulceration & 1 & 1.7 \\
Necessity of relining + occlusal adjustment & 1 & 1.7 \\
Necessity of relining + ulceration & 1 & 1.7 \\
Ulceration + dislodged attachment clip & 1 & 1.7 \\
Necessity of occlusal adjustment + dislodged attachment clip & 1 & 1.7 \\
Dislodged attachment clip + loss of retention & 1 & 1.7 \\
Necessity of relining + ulceration + loss of retention & 1 & 1.7 \\
Necessity of occlusal adjustment + dislodged attachment clip + loss of retention & 1 & 1.7 \\
Necessity of occlusal adjustment + ulceration + fracture & 1 & 1.7 \\
Necessity of relining + occlusal adjustment + screw loosening & 1 & 1.7 \\
Necessity of relining + occlusal adjustment + loss of retention & 1 & 1.7 \\
Necessity of relining + occlusal adjustment + loss of retention + dislodged attachment clip & 1 & 1.7 \\
Necessity of relining + occlusal adjustment + loss of retention + dislodged attachment clip + ulceration & 1 & 1.7 \\
Necessity of relining + fracture + loss of retention + dislodged attachment clip + ulceration & 1 & 1.7 \\
\hline
\end{tabular}
\caption{The distribution of prosthetic complications}
\end{table}
part during the first 5 years.\textsuperscript{13} Considering the fact that activation of female parts is less time-consuming than is changing them, an advantage for the rigid attachment was pointed out.\textsuperscript{13} This fact had been confirmed by the slightly higher incidence of all types of complications for the ball attachment devices in the present study. Nevertheless, in contradiction, it was reported in a study that there was a higher number of technical complications per patient with bars than with ball attachments, and the mean frequency of complications per patient per year was 1.0 in the bar group and 0.6 in the ball group during the 5-year observation period.\textsuperscript{3}

An in vivo study has shown that during chewing, bars with distal cantilevers tend to increase the loads on the most distal implants by more than 3 times.\textsuperscript{46} For this reason, none of the bar designs in our study had cantilever extensions, which could be the reason for the slightly better results in favor of the bar attachments.

Alloy selection for the construction of the superstructure also seems to be important.\textsuperscript{47} If a soft gold alloy is used instead of a rigid

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\hline
& Ball (n = 25) & Bar (n = 16) & Locator (n = 18) & \\
\hline
\hline
Prosthetic complications & & & & \\
None & 8 (32.0) & 6 (37.5) & 6 (33.3) & .576 \\
1 complication & 8 (32.0) & 8 (50.0) & 7 (38.9) & \\
More than 1 complication & 9 (36.0) & 2 (12.5) & 5 (27.8) & \\
\hline
Complication type & & & & \\
None & 8 (32.0) & 6 (37.5) & 6 (33.3) & .711 \\
Adjustment & 3 (12.0) & 4 (25.0) & 2 (11.1) & \\
Repair & 8 (32.0) & 5 (31.3) & 5 (27.8) & \\
Adjustment and repair & 6 (24.0) & 1 (6.3) & 5 (27.8) & \\
Need of relining & 8 (32.0) & 1 (6.3) & 1 (5.6) & .030* \\
Ulceration & 6 (24.0) & 2 (12.5) & 4 (22.2) & .653 \\
Dislodged matrix & 4 (16.0) & 1 (6.3) & 5 (27.8) & .245 \\
Loss of retention & 8 (32.0) & 2 (12.5) & 5 (27.8) & .362 \\
\hline
\end{tabular}
\caption{The evaluation of prosthetic complications related to the attachment type\textsuperscript{†}}
\end{table}

\textsuperscript{†}\chi^2 test.

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\begin{tabular}{|l|c|c|c|c|}
\hline
& 2 & 3 & 4 & \\
\hline
n (%) & n (%) & n (%) & \\
\hline
Prosthetic complications & & & & \\
None & 9 (28.1) & 9 (47.4) & 2 (25.0) & .095 \\
1 complication & 10 (31.3) & 8 (42.1) & 5 (62.5) & \\
More than 1 complication & 13 (40.6) & 2 (10.5) & 1 (12.5) & \\
\hline
Complication type & & & & \\
None & 9 (28.1) & 9 (47.4) & 2 (25.0) & .266 \\
Adjustment & 3 (9.4) & 4 (21.1) & 2 (25.0) & \\
Repair & 10 (31.3) & 5 (26.3) & 3 (37.5) & \\
Adjustment and repair & 10 (31.3) & 1 (5.3) & 1 (12.5) & \\
\hline
\end{tabular}
\caption{The evaluation of prosthetic complications related to the implant number\textsuperscript{†}}
\end{table}

\textsuperscript{†}\chi^2 test.
nonprecious alloy, the resistance of the superstructure to bending decreases by two-thirds. As a result, the stress is about 50% larger compared with the values obtained by the rigid superstructure. Important parameters influencing the stress distribution include material properties, such as the modulus of elasticity. The bars in the present study have been constructed with rigid alloys such as CoCrMo alloy (DEGUSSA, Degussa-Hüls AG/Germany; 63% Co, 28% Cr, 5% Mo, 4% others) or gold-palladium alloy (Security, Jensen Dental, North Haven, Conn; 40% Au, 40% Pd, 9% Ag, 11% others). The rigidity could have been another reason explaining the success of the bar attachments in the present study.

When more than 2 implants and multiple bars are used between implants, as in our study, the attachment clips located on each bar are often not parallel to each other or perpendicular to the posterior ridges. In these situations, the clips can bind in function, thus limiting the movement of the prosthesis. Use of a rigid joint between bar and the denture usually places more load on the implants than on the denture-bearing mucosa surfaces. However, a clinical study that measured the force transmission onto implants supporting OVDs found that maximum forces measured in the vertical direction were higher with single telescopes than with bars and clips and that rigid bars contributed to load sharing between the implants. Although further investigation is necessary, it could be stated that if the prosthesis is well designed and under ideal conditions, there is no significant difference between ball attachments and bar-clip designs in terms of stress distribution to the implants.

Considering other kinds of maintenance requirements, it was emphasized by several authors that OVDs with rigid attachments show less need to be relined. Resilient attachments are claimed to conduct undesirable forces to the denture-bearing tissues, resulting in resorption, which makes relining necessary. It should be kept in mind that the denture-bearing tissues are subject to changes and atrophy over time, which is another reason revealing spaces under the denture base makes relining necessary. In the present study, the need for relining was predominately seen in ball attachments (Table 2), confirming the above-mentioned studies. However, it was observed that locator attachments did not cause the significant relining needs the ball attachments did. This may be due to the dissimilar resilience mechanisms of 2 attachment types.

The cause of mechanical complications might be expected to be overloading and insufficient number of implants, but no study has been able to prove that. On the contrary, in a review it was concluded that the success rate of implants and prostheses or patient satisfaction with the OVD treatment of the mandible is not dependent on the number of implants or abutment type. If cost-effectiveness is the preliminary goal, a 2-implant OVD is reported to provide an excellent alternative to a conventional complete denture, and there are clinical studies reporting successful rehabilitation with mandibular OVDs anchored to only a single implant in the midline of the mandible. The results of the present study failed to show a statistically significant correlation between implant number and occurring complications, although there was a numerical trend indicating fewer complications with more implants supporting the mandibular OVDs (Table 3). In addition, the evaluation of the maximum bite force of the patients showed no significant relation with complications. To draw more reliable conclusions, further studies with a larger patient population and a longer observation period should be conducted.
CONCLUSIONS

Within the limitations of this study, the following conclusions can be drawn:

1. Twelve months following the denture insertion, there seems to be no statistically significant relation between occurring complications and factors related to patients, such as maximum bite force or age and gender of the patient, as well as factors related to the overdenture, such as number and type of attachments.

2. Although the results show a trend toward fewer complications with the bar attachment, this finding is not statistically significant.

ABBREVIATION

OVD: mandibular implant overdenture

REFERENCES


