COMPLICATIONS WITH IMPLANT SUPPORTED OVERDENTURES: A PROSTHODONTIC REVIEW

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ABSTRACT

Implant-supported or implant-retained overdentures in the mandible provide predictable results with improved stability, retention, and patient satisfaction. Scientific evidence shows a lower rate of implant survival and a higher frequency of prosthetic complications for maxillary implant-retained or implant-supported overdentures. Although the literature presents considerable information on complications of implant prostheses, variations in study design preclude proper analysis of certain complications. Well-designed longitudinal studies are required to establish evidence-based treatment planning principle.

Introduction:
Edentulous patients with a severely resorbed mandible or maxilla often experience problems with conventional dentures, such as insufficient stability and retention, together with a decrease in chewing ability. Because of the good prognosis of dental implants, these patients can be successfully treated with implant-retained or implant-supported overdentures. Several studies reported the following benefits of overdenture in comparison to complete denture treatment in the mandible: better chewing ability, better fit and retention, improved function, and improved quality of life. Controversially, very few studies have evaluated patient satisfaction with maxillary overdentures. Data show that there is no significant improvement of the above parameters for overdenture wearers when good bony support exists for the fabrication of maxillary conventional prostheses. However, since many patients have problems with the retention of their mandibular prosthesis and do not desire implant-supported fixed prostheses, mainly because of financial reasons, the removable implant-retained or implant-supported overdenture has become a reliable treatment alternative, offering the same masticatory efficacy as a fixed prosthesis.

The lack of systematic terminology for implant prostheses requires the need for standardization of the terms used. According to “The Glossary of Prosthodontic Terms,” an overdenture is defined as “a removable partial or complete denture that covers and rests on one or more remaining natural
teeth, roots, and/or dental implants; a prosthesis that covers and is partially supported by natural teeth, tooth roots, and/or dental implants.” An implant-supported overdenture is defined as a prosthesis that obtains its entire support from dental implants, while an implant-retained overdenture gains its support from a combination of intraoral tissues and dental implants. Studies have been carried out over the last 2 decades to evaluate the benefits of implant-supported or implant-retained overdenture therapy. Various treatment concepts involving different numbers and types of implants, as well as different retention mechanisms, have been proposed. Bars, magnets, ball attachments, and rigid and nonrigid telescopic copings have been used to retain overdentures. The clinical outcomes of different attachment systems were evaluated in a limited number of randomized controlled clinical trials (RCTs). In addition, most prospective studies with a follow-up period of at least 5 years focused exclusively on implant survival, while few studies evaluated the surgical and prosthetic complications in a 10-year observation period. It is obvious that there is a critical gap in the general understanding of the types and rates of prosthetic complications associated with a particular retention system or overdenture design. An evaluation of the long-term outcome of implant overdentures and complications associated with different attachment systems may provide useful guidelines for the clinician in selecting the type of attachment system and overdenture design.

The purpose of this review was to provide information on the types of prosthodontic complications associated with implant-retained or implant-supported overdentures.

**Implant Survival/Success and Type of Attachment:**

The current literature revealed only 14 prospective studies and 4 RCTs addressing the prosthetic complications and implant survival/success rates of patients treated with implant-supported or implant-retained overdentures after a period of at least 5 years. Information regarding implant-supported or implant-retained overdentures in the maxilla was found in only four studies, none of which were RCTs. Maxillary overdentures generally involved an implant-splinted bar on a maximum of four to six implants. The implant success rate ranged between 72.4% and 84%, and the implant survival rate was 75.4%. The study of Attard and Zarb reported a cumulative survival rate of all implants (maxilla and mandible) of 96% and a cumulative success rate of 93%. According to the systematic review of Bryant et al, the pooled implant survival estimate was 76.6% at 5 years. Data regarding survival rates of implants after observation periods of more than 10 years were in short supply. As for the outcomes of mandibular implant-supported
or implant-retained overdentures, it seems that there is more evidence available than that with maxillary overdentures. Of the 17 studies identified, only 4 were RCTs, and 4 of the prospective studies had an observation period of at least 10 years. The majority of studies employed bars, balls, or magnets as attachment systems. Only one additional study evaluated soft and hard tissue conditions as well as the function of telescopic copings for implant overdentures. In most studies, overdentures were supported by two implants, but there were also studies with one, three, four, or more implants. Implant survival did not appear to vary by splinting, rotational characteristics, or the number of implants and ranged from 93% to 100% at 10 years. Bryant et al showed that the pooled implant survival rate in the mandible after 10 years was 95.4%. The statistical finding that implant survival in the mandible exceeds the outcomes in the maxilla reinforces the long-established evidence of a somewhat elevated vulnerability of the edentulous maxilla for implant failure. Although no clear evidence is available, several studies demonstrated that failures in the maxilla are related to short implants, poor bone quality or quantity, and a small number of implants. However, the recent development in the field of new implant surfaces could lead to higher integration rates in the maxilla.

Definition of Clinical Complications:

There are two categories of complications that occur in implant therapy: biologic and technical (mechanical). The present review focused on the technical complications that were related to implant-supported or implant-retained overdentures. “Technical complications” served as a collective term for mechanical damage to the implant and implant components and superstructures. Such complications included implant fracture, wear or corrosion of the retention elements, fracture of the retention elements or superstructure, abutment fracture, abutment screw loosening or fracture, attachment screw loosening or fracture, activation or changing of the clip, matrix activation (change of rubber ring) or replacement (change of O-ring housing), changing of the magnet, rebasing or relining of the overdenture, and overdenture fracture.

Prosthetic Success and Incidence of Technical Complications:

In contrast to implant survival/success rates, the percentage of prosthetic survival/success ranged widely between the studies and prosthetic types and was generally not calculated cumulatively. The data obtained showed that prosthetic maintenance is inconsistent between different studies. Variable definitions of events, visits, and occasions were used with or without accounting for prosthetic maintenance conducted at routine
reassessment visits. Bryant et al could not calculate an overall complication incidence for implant overdentures because there were no multiple clinical studies with a similar study design that simultaneously evaluated all or most of the categories of complications. On the other hand, Berglundh et al, in a systematic review, observed that a 4- to 10-times higher incidence of prosthetic complications was associated with implant-supported or implant-retained overdentures in comparison to implant fixed prostheses. Goodacre et al combined raw data from multiple studies and calculated means in an attempt to identify trends noted in the incidence of complications. For a specific complication to be included, three or more studies must have reported data related to the incidence of that particular complication. The authors clarified that the mean percentages presented in their study suggested trends rather than absolute incidence values and should be interpreted cautiously due to the large variation in numbers of implants and prostheses evaluated and the lack of statistical analysis. The following complications were reported (listed in order of frequency): overdenture loss of retention or adjustment (30%), overdenture rebasing or relining (19%), clip or attachment fracture (17%), overdenture fracture (12%), opposing prosthesis fracture (12%), acrylic resin base fracture (7%), prosthesis screw loosening (7%), abutment screw loosening (4%), abutment screw fracture (2%), and implant fracture (1%). Irrespective of the anchorage system used, adjustments to the overdenture attachment system were the most common mechanical problem in implant prosthodontics. In an RCT, Naert et al compared the prosthetic aspects of three different attachment types (ball, bar, and magnets) in two implant-retained mandibular overdentures. In the ball group, renewal of the O-ring housing and rubber ring and abutment screw loosening were the most common mechanical complications after an observation period of 10 years. In the magnet and bar groups, the most frequent complications were wear and corrosion and the need for clip activation, respectively. Compared to the bar group, the magnet and ball groups presented the highest incidence of prosthetic complications.

Conversely, significantly more complications and repairs were reported in the bar group compared to the ball group during the first year of function. However, no significant differences between the different attachment systems were observed in the following years. Another point of concern is the distinction between resilient (Dolder) and rigid (milled) bars regarding their prosthodontic maintenance. In contrast to well-established clinical use and the numerous publications regarding hinged overdentures, very few data exist comparing the use of resilient or rigid bar stabilization. In a recent study, Krennmaire et al reported that when four interforaminal
implants were used to anchor mandibular overdentures, the design of the anchorage system significantly influenced the need for prosthodontic aftercare. Rigid anchorage using milled bars and a metal-reinforced denture framework required less prosthodontic maintenance than resilient denture stabilization with multiple round bars and dentures without frameworks. Similarly, Dudic and Mericske-Stern found a significant superiority of the mandibular rigid bar design versus the resilient bar configuration after 2 and 5 years of follow-up but not after a period of 15 years. A change from a resilient retention device to a rigid bar was performed more often than vice versa, but not at a statistically significant level. Concerning the telescopic crowns as an anchorage system for implant overdentures, there are very limited long-term data in the literature. In the only longitudinal prospective study included, Heckmann et al investigated the clinical function of nonrigid telescopic crowns over an observation period of 10 years. Out of a total of 46 telescopic crowns (16 cemented and 30 screw-retained), 4 primary copings had to be recemented during the follow-up period (25%), while loosening of the occlusal screw occurred in 5 implants (16.6%). Relining of the overdentures occurred with an incidence of 21.7%. In general, a higher incidence of mechanical problems was reported with implant-supported or implant-retained overdentures in the maxilla compared to those in the mandible, especially for maxillary overdentures without palatal coverage. Limitations in vertical space for the prosthetic components and matrix were more common in the maxilla, which resulted in compromises in design and material failure. After a 5-year follow-up, Watson et al. reported a threefold increase in fractures of overdentures in the maxilla compared to those in the mandible. However, a cast chromium-cobalt framework reinforcement was reported to eliminate this complication. Regardless of the anchorage system, the predominant complication in maxillary overdenture therapy involved a change in the retention system resulting from loosening or fracture of the prosthetic components.

Comparison of the Four Anchorage Systems Used

<table>
<thead>
<tr>
<th>Type of anchorage</th>
<th>Retention</th>
<th>Space requirement</th>
<th>Cleansibility</th>
<th>Costs and technique sensitive</th>
<th>Aftercare</th>
<th>Patient satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bar</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ball attachments</td>
<td>2-3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Telescopic crowns</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Magnets</td>
<td>1</td>
<td>1</td>
<td>2</td>
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<td>3</td>
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</tbody>
</table>

1 = least effective; 3 = most effective
Discussion:

In the present review, a number of longitudinal cohort studies were analyzed with respect to prosthodontic complications related to implant-retained or implant-supported overdentures. The main approach in the search was to identify studies of prospective design with follow-up periods of at least 5 years. Although the gold standard for systematic reviews is to study RCTs, which have the most robust design, most of the studies included in this review were prospective clinical trials. A retrospective study design and duration of < 5 years were the main reasons for exclusion. Several retention systems for implant overdentures have been described in the literature. Differences between studies in regards to methods and lack of standardization of prosthetic procedures, as well as insufficient sample size, have prevented an objective assessment of the preferred retention system for implant-retained or implant-supported overdentures. The choice of a specific system seems to be based more on the clinician’s preference than on scientific evidence. Several clinical longitudinal studies have shown that there are no differences in implant survival and peri-implant variables between bar and unsplinted retention systems.

Comparison of the Four Anchorage Systems:

Although there is no significant difference in patient satisfaction with overdenture stabilization between the different attachments (both implant-supported and implant-retained), differences have been described regarding prosthetic maintenance during the follow-up period (Table 1). For selection of the appropriate type of attachments, the oral status, the financial situation of the patient, cost-effectiveness, and the patient’s expectations of the new overdentures must be considered. The anatomical situation in the mandible or maxilla is a critical factor. Advanced atrophy of the alveolar crest calls for prosthetic stabilization, especially with regard to horizontal forces, which can be achieved predominantly with bars and telescopic crowns. As a result of the presenting anatomy of the mandible or because the implants are placed in excessively distal locations, the tongue space may be restricted when using bars. More common limitations in the maxilla are in vertical space for the prosthetic components and matrix due to contour and phonetic considerations. In the vertical axis, a minimum distance of 13 to 14 mm from the implant platform to the incisal edge of the overdenture is necessary for the bar attachment, allowing 4 mm for the bar and 1 mm between the bar and gingiva for hygiene, as well as space for the clip and the acrylic/tooth housing. Solitary anchors require only 10 to 11 mm of vertical space above the implant platform and therefore offer more flexibility. It also has been demonstrated that solitary attachments are less costly and less technique
sensitive, while clinical experience shows that secondarily blocked constructions ease oral hygiene procedures considerably for elderly patients compared with bars. In a comparative study, the bar group revealed more mucositis and gingival hyperplasia, whereas the solitary attachment group displayed more decubitus ulcers. Several longitudinal prospective studies have shown that there is no significant difference in the implant survival rate and marginal bone loss between subjects with overdentures retained with splinted or unsplinted anchorage systems. Van Kampen et al demonstrated that bars provide more retention than solitary anchors when subjected to both vertical and oblique forces. Implant angulation may compromise the retention of solitary anchors. However, Chung et al showed that in cases of parallel-placed implants, solitary attachments such as Locators may match or exceed the Hader bar and metal clip retention. Naert et al demonstrated that the ball group presented the highest vertical retention capacity of the implant-retained overdenture and a remarkable increase in this retention capacity over time, whereas a decrease occurred in the magnet and bar groups. Magnets have been shown to be the least retentive of all attachment systems but may be appropriate for patients with bruxism or dexterity problems. Finally, the extent of prosthetic maintenance using different attachment systems should be considered. When comparing bars with single anchors, controversy exists as to whether the bar or ball design requires more maintenance. Several studies have shown that there is no correlation between attachments and prosthetic complications, except for bars with distal extensions, which were more prone to fracture. It has also been shown that rigid bars retaining overdentures on four implants demonstrate a significantly lower incidence rate of prosthodontic maintenance than a resilient anchorage system with round bars. In the study by Dudic and Mericske-Stern, fracture of bars or extensions and retightening of female parts was higher in the rigid group, whereas broken, loose, or lost retainers required significantly more repairs in the resilient group. Other studies demonstrated an increased amount of prosthetic maintenance for ball attachments and magnets because of wear or fracture of the ball head or need for activation of the ball matrix and corrosion or wear of the magnets. In terms of maintenance, the bar and the Locator attachment systems have been recommended when restoring implants with a divergence between 10 and 40 degrees. However, clinical studies comparing prosthetic maintenance of Locators with other attachment systems are in short supply.

Etiology of Technical Complications:
To minimize potential problems during and after the restorative phase, attention must be paid to various factors that can lead to mechanical
complications. A common problem associated with the prosthetic restoration of dental implants is loosening or fracturing of the attachment screws. This complication occurs mainly because of the magnitude and direction of the oral forces and the strength limitations of the components. Other factors such as operator error, torsion relaxation, and thermal changes may also contribute to screw loosening. Moreover, the amount of ridge resorption, the length and number of implants, the opposing dentition, the angulation of the implants, and parafunctional habits may increase the susceptibility for such complications. In the severely resorbed mandible, implants supporting or retaining an overdenture may be subjected to excessive masticatory forces by the mesial and distal cantilever and also from the occlusogingival lever arm. These forces include off-axis centric contacts, excursive contacts, cantilevered loading, and internal stresses created by both component and framework misfit. In the case of angulated implants, the occlusal forces may generate more strain than the screw can bear. In addition to implant fracture, prosthesis fracture or acrylic resin failure or wear may occur. Such complications are observed when the applied loads exceed the material’s proportional limit or fracture strength.

Other technical failures, such as material contamination, casting porosities, and poor alloy surface preparation, may also lead to prosthetic complications. Misfit of the framework has also been suggested as an important factor as far as prosthetic failures are concerned. It should be considered that an absolute passive fit of a framework is almost impossible. However, studies designed to assess the effects of the degree of misfit of an implant-supported or implant-retained restoration on the implant bone-phase boundary have been unable to demonstrate a negative effect of misfit on this area. Within the limits of this review, treatment recommendations have been posited given the available evidence. Therefore, cantilever lengths should be minimized, nonworking contacts should be eliminated, centric occlusion contacts should be centralized, and components should be torqued in accordance with manufacturer recommendations. Much effort should be taken to improve the fit of the prostheses. As the etiologies of many technical complications are not fully clear, the clinician is left to weigh the costs and complexity of treatment. According to the principles of evidence-based dentistry, it is agreed that an RCT is the most scientifically sound method to establish reliable conclusions regarding the effectiveness of therapeutic alternatives. The proportion of RCTs in the prosthodontic literature is, however, very small and further research is needed to provide better answers to the “how” and “why” of successful implant-supported or implant-retained restorations. The effects of design variables such as anchorage
system used, maintenance, costs, patient satisfaction, and success of the reconstruction require better quantification and documentation so that basic guidelines can be established.

Conclusions:

There is scientific evidence that a lower rate of implant survival and a higher frequency of prosthetic complications exist for maxillary implant-retained or implant-supported overdentures. The heterogeneity of studies dealing with prosthetic aftercare and maintenance does not allow an estimation of an overall complication rate. Further well-designed RCTs are required to establish evidence-based treatment planning principles for implant overdenture patients

References


