Complications Associated with Implant-Retained Removable Prostheses

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KEYWORDS

- Implant mechanical complications • Implant-supported overdenture
- Implant-supported removable prostheses
- Implant-supported removable partial dentures

KEY POINTS

- Implant-supported removable prostheses improve patients' satisfaction with treatment and quality of life.
- These prostheses are associated with biological and mechanical complications.
- The mechanical complications associated with implant-supported overdentures and implant-supported removable partial dentures include loss of retention of attachment systems, the need to replace retention elements and to reline or repair the resin portion of the denture and implant fracture.
- Implant-supported removable prostheses are very successful but require periodic maintenance.

INTRODUCTION

The changing demographics of the population in the United States and other Western countries have created a shift in the rates and patterns of edentulism.[1] Although the overall trend is toward a decrease in complete edentulism, the group in greatest need of complete or partial oral rehabilitation is the rapidly growing aging population. A study conducted by Douglass and colleagues[1] in 2002 concluded that, "The 10% decline in edentulism experienced each decade for the past 30 years will be more than offset by the 79% increase in the adult population older than 55 years.[1]"

Conventional complete and partial dentures have historically been the treatment options of choice for patients desiring removable prostheses. These options have been suitable for patients with limited financial resources who prefer noninvasive treatment. However, these treatment options are not without complications. In general, the

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success of conventional complete dentures depends on starting with appropriate oral anatomy, such as minimally resorbed ridges, arch forms resistant to displacement, and palate forms conducive to denture stability. Of course, obtaining the ideal oral anatomy is rarely possible, especially if a patient has remained edentulous for several years before wearing dentures. The resulting complete dentures may lack stability and retention, affecting mastication and speech, and the overall effect has been a negative on the patient's quality of life. Patients may withdraw socially if they have a fear of being unable to eat or of losing their dentures when speaking. The edentulous mandible tends to be of more concern to denture wearers than the edentulous maxilla.

Conventional partial dentures, especially those with mandibular distal extension bases, present their own set of complications, primarily rotation around the distal abutment, which creates discomfort because of an unstable denture base. This problem can call for periodic relining of the denture for the purpose of maintaining occlusal contacts and avoiding traumatic occlusal forces that cause ridge resorption or damage to abutment teeth because of the difference in resilience between teeth and mucosa.

With advances in osseointegrated implants and the success of fixed dental prostheses has come a change in treatment options for patients who desire removable prostheses but who have completely or partially edentulous ridges. Treatment options include complete or partial dentures retained by single or multiple endosseous implants, which may or may not be splinted, and a variety of attachments, such as ball attachments, Locator abutments, bar attachments, and even magnets.

A panel of subject experts at a 2002 symposium[2] in Montreal, Ontario, Canada, concluded that "The evidence currently available suggests that the restoration of the edentulous mandible with a conventional denture is no longer the most appropriate first choice prosthodontic treatment. There is now overwhelming evidence that a two-implant overdenture should become the first choice of treatment for the edentulous mandible." A subsequent statement was released after the 2009 meeting of The British Society for the Study of Prosthetic Dentistry in York, United Kingdom.[3] This panel concluded that "A substantial body of evidence is now available demonstrating that patient's satisfaction and quality of life with ISOD (implant-supported overdentures) is significantly greater than for conventional dentures." Although the ISOD has not yet been deemed the gold standard of care, it is certainly seen as the first choice for removable prostheses.

Even with the progress of implant dentistry, complications are associated with implant-retained removable prostheses. Such complications may arise from the integration of the implants themselves, or from the design of the prosthesis. Failures or complications may result from a variety of factors, such as the number of implants placed and their location. For instance, the number of implants required for a successful prosthesis may vary depending on occlusal forces and the quality and quantity of bone present. The types of attachments selected by the operator may result in various degrees of stability. The content of this article is intended to focus on the failures and complications associated with implant-retained prostheses and to provide some insight into the prevention of complications and solutions to the problems when failures do occur.

NUMBER AND LOCATION OF IMPLANTS

Overdentures

The issues associated with stability and retention of conventional complete dentures, especially those in the mandible, have resulted in new treatment options. In the 1960s,

clinicians began using natural tooth roots that had undergone root canal treatment as abutments for dentures; this procedure became a means of increasing the retention of dentures. With few available studies to guide the methodology for choosing the abutments, the standard protocol was to use anterior teeth, typically at least 2 teeth, especially in the mandible. This protocol was based on the fact that mandibular anterior teeth were usually the last to be lost and the easiest to treat endodontically. However, during the 1970s and 1980s the trend for denture abutments began to move away from natural abutments and toward implant abutments. This change coincided with the increase in published studies related to implant placement.

During treatment planning for an overdenture (OD), it is important to question not only whether there are an ideal number of implants that will maximize the retention of an ISOD but also how their location (maxilla or mandible) affects the outcome.

Mandible

The compact bone structure of the mandible and its dense cortical plates make the largest facial bone a good recipient for implants. Several published studies have shown that patient satisfaction is higher with mandibular implant-retained ODs than with conventional dentures in the areas of stability, retention, chewing function, and even esthetics. In determining the design of a mandibular implant OD, the clinician must consider how many implants are necessary to create improved function without subjecting the patient to excessive surgical procedures.

In 1987, Van Steenberghe and colleagues[4] were among the first authors to support the placement of only 2 mandibular implants for an OD. They reported a 98% success rate with a 52-month follow-up. A 2012 review of the McGill and York consensus statement[3] also concluded, on the basis of the results of several randomized controlled studies, that the placement of 2 mandibular implants for an OD is a minimum standard for patient satisfaction with regard to improved function. Does this mean that the placement of additional mandibular implants is considered unnecessary? According to the findings of a literature review by Sadowsky,[5] which cited a study by Jacobs and colleagues[6], the annual posterior mandible resorption rate was 2 to 3 times higher for patients with OD than for those with conventional complete dentures. Although anterior mandibular bone resorption decreased from 0.4 mm annually to approximately 0.1 mm annually (Atwood and Coy[7] and Tallgren[8]) with the placement of anterior interforaminal implants, this was not the case in the posterior mandible without implants. Sadowsky[5] concluded that, for younger patients or those edentulous for less than 10 years, an OD with 2 implants may actually be contraindicated. Instead, using more implants in the posterior mandible to create a fixed prosthesis not only preserved bone but helped to regenerate bone.[9]

The opposing arch also appears to affect the design of mandibular ODs. Placing a mandibular OD against a conventional complete maxillary denture can generate sufficient occlusal force to the premaxilla area to cause bone resorption and soft tissue inflammation. This problem, as reported by Haraldson and colleagues,[10] can lead to a higher incidence of midline fracture of the maxillary prostheses. To reduce this combination syndrome[11] effect, Thiel and colleagues[12] recommend using an occlusal design, removing anterior contacts in centric relation, and minimizing excursive contacts.

A study by Merickse-Stern[13] concluded that retention, stability, and occlusal equilibration of dentures improve only slightly with an increasing number of implants. Another in vivo study by Fontijn-Tekamp[14] compared the placement of 2 or 4 transmandibular implants and found that the masticatory forces were not significantly different between implant-supported and soft tissue implant dentures. Sadowsky[5] concluded that,

although the use of 2 implants does improve function, some scenarios call for the placement of more implants in the mandible, such as a maxilla with natural teeth, which would increase the masticatory forces on the mandible; implants that are less than 8 mm in length or less than 3 mm in width; soft tissue that would be sensitive to occlusal loading; high muscle attachments or sharp mylohyoid projections; large V-shaped ridges; and patients' demand for high retention.

Although 2-implant and-4 implant designs seem to be the most discussed for mandibular ISODs, in 2010 Gonda and colleagues[15] performed a study comparing the use of a single implant in the mandibular midline area to the use of 2 implants. Differences in the rates of fracture of the denture acrylic base were not statistically significant; thus, the authors concluded that, for patients who are older, with larger financial constraints, and the inability to undergo more involved surgical procedures, a single mandibular implant may be adequate for OD retention.

In 2002 the McGill consensus statement[16] concluded that "OD treatment of the mandible having more than two implants does not lead to a more satisfied individual in terms of denture and social function." However, Fitzpatrick[17] states, in his "Standard of care for the edentulous mandibles" that "No single treatment modality or technique for tooth replacement can fit all patient requirements." Therefore, it is good data collection, discussion with the patient of desires and goals, and treatment of the mandible as a component of the entire oral makeup instead of on its own that will allow the clinician to construct an OD design with an appropriate number of implants for a specific patient.

The number of implant fixtures required for a mandibular OD will vary based on the amount of remaining bone that supports the basal seat of the denture, width and the length of the implants to be used. The patient's general health condition is also a contributing factor.

Maxilla

Although numerous studies report significant improvement in denture function with the placement of implants in the mandible, the same cannot be said for the maxilla. De Albuquerque Junior and colleagues[18] reported that implant prostheses in the maxilla will probably have the most impact when a patient is struggling with conventional maxillary dentures. Maxillary trabecular bone is not naturally conducive to primary implant stability, and bone resorption patterns can create unfavorable occlusal forces.[19] Many studies[20–22] have reported that lower maxillary implant survival rates are correlated with decreased quality and quantity of bone, implant angulation that follows the resorption pattern of bone, and increased abutment length caused by thickened maxillary mucosa. Therefore, an ISOD may not be the best choice if appropriate bony support is available for a conventional denture. The clinician should evaluate an existing denture for stability, retention, and overall function and relate those findings to the patient's complaints.[23] Because maxillary ODs do not have palate extension, they are preferred by patients who cannot tolerate palatal coverage (**Fig. 1**).

If the existing denture is ill-fitting or the esthetics are unacceptable to the patient, a new denture must be fabricated. At the wax try-in, the patient must be satisfied with the arrangement of the teeth so that a duplicated denture can be used as a surgical guide for implant placement. The arrangement of the teeth will also determine the space available for retainers and attachments.

When working with the maxilla, the clinician must contend with cavities specific to that bone, such as sinuses and the nasal cavity. It is the anatomy of the jaw that drives the location and placement options for implants, which in turn drive the design of the prosthetic. Therefore, before designing a maxillary prosthesis or placing implants, the

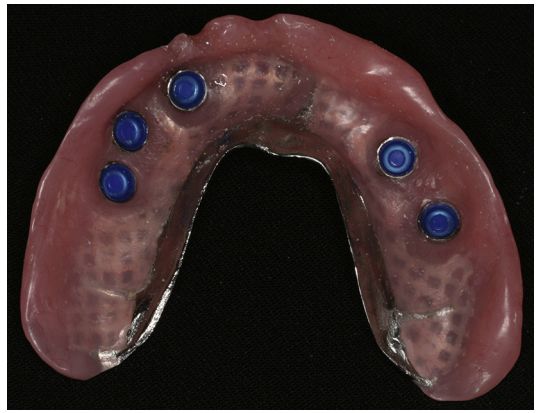

Fig. 1. Maxillary OD, palate-less, with free-standing attachments.

clinician must focus treatment planning on data collection using appropriate radiographic tools, such as computed tomographic scans, for measuring the volume of available bone for implants.

The resorption pattern is important for implant placement. Anterior-posterior resorption of more than 10 mm or substantial maxillary vertical resorption that renders the implant components visible during speech can dictate anterior implant positioning. If too much maxillary anterior bone is present, the clinician may opt to avoid placing implants in the premaxilla to avoid detrimental impacts on OD frameworks that are space-sensitive.[23] In such a case, the posterior ridges may be favored over the anterior ridges for implant placement.

The resorption pattern of the maxillary posterior ridges is medial and superior. Relative to the mandibular arch, the resulting jaw/tooth relationship may be jeopardized, placing undue force on prostheses or implants.

Once the diagnostic data have been collected and evaluated, implant placement can be determined and the prosthetic can be designed, with constant focus on the esthetic goals of the clinician and the patient. Although Branemark and colleagues[24] consider 4 ideally placed implants to be sufficient for prostheses, Eckert and Carr[25] advocate at least 6 maxillary implants for prosthetic success. The primary reason for this difference in recommendation is that failure of 1 of 4 implants will result in the loss of an important component that was integral to the design of the prosthetic, whereas the loss of 1 of 6 implants may still give the clinician room to modify the design.

Per Boucher,[26] the hard palate is the primary *supporting* area of a maxillary denture. Thus, the authors recommend that a palate-less denture be supported by at least 6 implants.[27]

Damghani and colleagues[27] found that the prosthetic design is affected not only by the number of implants placed but also by the distance between them. An in vitro study showed that the decrease in the difference of force to the palatal area was larger with 4 implants placed a maximum of 8 mm apart than with 2 implants. The overall difference in force on the palate was highest with 4 implants placed a maximum of 24 mm apart, but this difference was not statistically significantly different from that achieved with 4 implants spaced 8 mm apart.

If total support by implants is not attainable, the clinician should consider retentive elements that allow prosthetic movement. This choice will serve to remove high stress

around the terminal implants that could cause, at the least, fracture of the OD acrylic base and, at most, fracture of retentive elements or loss of the implant (Fig. 2).

Eckert and Carr[25] recommend that multiple implants should be left unsplinted if an implant has failed before prosthodontic fabrication.

MECHANICAL COMPLICATIONS OF IMPLANT SUPPORTED OVERDENTURES

A review of the published literature showed that implant-supported mandibular ODs are successful both biologically and mechanically. Andreiotelli and colleagues[28] reported that implant-supported ODs in the mandible provide predictable results. A lower rate of implant survival and a higher rate of mechanical complications seen for implant-supported maxillary ODs.

The following mechanical complications of ISODs have been reported: loss of retention of attachment systems, replacement or activation of retentive elements, loosening of screws, the need for relining or repairing the resin portion of the denture base, pop-out of denture teeth, and implant fracture (Figs. 3–5).[29] Various attachment systems have been used with ISODs, such as ball attachments, bar systems, and Locator attachments (Zest Anchors, Inc, Escondido, CA, USA). The most common mechanical complication associated with OD is maladjustment of the attachment system, regardless of the type of attachment used.

An important question is whether the attachment systems should be splinted or left unsplinted. Stoumpis and Kohal[30] reported no difference in implant survival rates between splinted and unsplinted systems. They also concluded that an unsplinted design requires more prosthetic maintenance. Naert and colleagues[31] found that the most common problem with mandibular ODs is replacement of the O-ring on ball attachments. The Locator attachment, which was introduced in 2001, is usually unsplinted. The attachment is a self-aligning, resilient dual retention system. It is available in various heights to fit several implant systems or brands.[32] Cakarer and colleagues[33] reported that the number of mechanical complications associated with the Locator attachment is lower than that for ball or bar attachments. Kleis and colleagues[34] compared 3 types of attachments on ODs supported by 2 implants and reported that all systems required maintenance of retentive elements within 1 year of follow-up.

The complications associated with the bar attachment system (splinted) are its bulk, the possibility of mucosal hyperplasia around the bar, oral hygiene problems, and the need for adjustment of the clip. In a systematic review of maxillary ISODs with a mean

Fig. 2. Loss of implant in a maxillary ISRPD.

Fig. 3. Resin fracture and pop-out of a tooth in an implant-supported OD.

observation of at least 1 year after placement, Slot and colleagues[35] found that the use of 6 implants splinted with a bar was the most successful system. Bar attachments also require more laboratory technique than other system.

Mechanical failure of bar attachments for ODs is caused by insufficient metal thickness, inferior solder joints, excessive cantilever length, and incorrect location of the implant.[36] Cakarer and colleagues[33] found that implant fractures most commonly occur with the ball attachment; they found no implant fractures with the Locator attachment (**Fig. 6**).

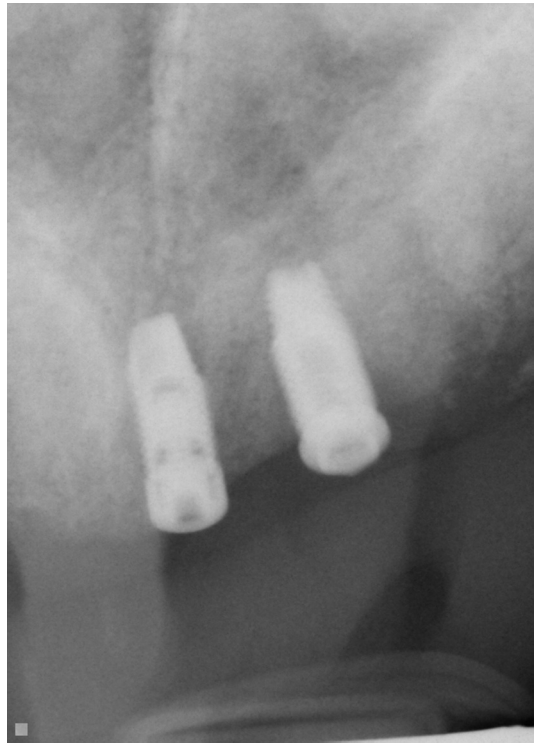

Fig. 4. Radiograph showing screw fracture.

Fig. 5. Bar and screw fracture in an OD.

There is no doubt that ISODs require mechanical maintenance. To reduce the frequency of these mechanical problems, practitioners must identify problems and find a simple solution to them.

The following are some recommended solutions for reducing the incidence of or solving the mechanical problems associated with ISODs:

1. The ODs must have proper extension and basal support. The fit of the denture base must be checked periodically. If necessary, the denture base should be relined or rebased as indicated.
2. The retentive elements of the attachment system must be checked and replaced as necessary.
3. To avoid fracture of the denture base, ISODs should contain a metal framework. The design and thickness of the metal skeleton must allow sufficient thickness of the acrylic resin.[37]
4. Instruction in oral hygiene and maintenance of soft tissue around the attachment systems are essential, especially with bar systems.
5. The distal extension of a bar attachment in resorbed mandibular ridges must not be too long. The use of the proper length will prevent bar fracture. Merickse-Stern[38] recommended that the cantilever part of the bar must not extend beyond the first premolars (**Fig. 7**).
6. Fabricating bar systems with CAD-CAM technology may lead to fewer mechanical failures.
7. The placement of multiple implants for supporting an OD, specifically in the maxilla, will simplify the repair of the prosthesis if an implant fails or fractures.

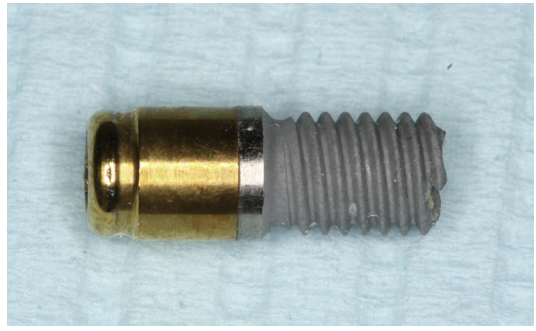

Fig. 6. Implant fracture with Locator attachment (free-standing).

Fig. 7. Fracture of the distal cantilever of the metal skeleton of prosthesis.

IMPLANT-SUPPORTED REMOVABLE PARTIAL DENTURE

Prosthetic management of partial edentulism is still challenging. Traditionally, the condition of the abutment teeth surrounding the prosthesis and the length of the edentulous span dictate the design of removable partial dentures (RPDs).

Differences in the viscoelastic responses of the abutment teeth and mucosal tissue to occlusal loading result in the transmission of torque forces to the abutment teeth. Such forces can increase the mobility of abutment teeth and decrease the retention and stability of the RPD. Torque force on the mucosa can create a shearing force on the underlying alveolar ridges, leading to increased bone resorption and requiring periodic relining of the posthesis to improve stability.[39]

The use of osseointegrated implants as direct retainers in implant-supported removable partial dentures (ISRPDs) has been indicated.[32] The use of implants in the distal extension areas within class I and II Kennedy RPDs has been recommended.[39,40] Such implant will increase the stability of the RPD, preserve bone, and increase retention.

In an in vitro study, Sato and colleagues[41] found that placing implant at the distal edentulous ridge can prevent displacement of the denture's distal extension bases. They found that the load on the bilateral first molar areas of ISRPDs is significantly less than that with conventional RPDs. Implant-retained or implant-supported RPDs improve retention and stability, minimize rotational movement, and significantly increase patient satisfaction.[42] Campos and colleagues[43] concluded that the use of implants with ball attachment retainers over a free-end RPD allowed patients to select harder foods to chew and resulted in smaller particle sizes at the time of swallowing than did conventional free-end RPDs.

Cunha and colleagues[44] reported that placing the implant closer to the abutment tooth placed less load on the supporting structures of that tooth. In addition, placing at least one implant in the edentulous area resulted in a lower stress load to the supporting tissues than that associated with distal extension RPDs. The use of free-standing resilient attachments is preferred within ISRPDs.[32,40,41]

COMPLICATIONS ASSOCIATED WITH IMPLANT-SUPPORTED REMOVABLE PARTIAL DENTURES

Mechanical complications associated with ISRPDs are similar to those associated with ISODs. In a systematic review of ISRPDs with distal extension, de Freitas and colleagues[45] found an implant survival rate of 95% to 100%. They reported that the complications associated with ISRPDs include the need for repairing or relining the prosthesis, the replacement of attachments, loosening of screws, and the need for repair of the acrylic denture base. Regardless of these mechanical complications,

these prostheses are low in cost and beneficial to the patient. The use of ISRPDs increases patient satisfaction.

SUMMARY

Implant-supported removable prostheses improve patients' satisfaction with treatment and quality of life. Improvements of implant surface and in attachment elements have made this treatment method very successful. Even so, these prostheses are associated with biological and mechanical complications. The mechanical complications associated with ISODs and ISRPDs include loss of retention of attachment systems, the need to replace retention elements and to reline or repair the resin portion of the denture, and implant fracture. Implant-supported removable prostheses are very successful but require periodic maintenance.

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