

Mandibular Implant-supported Overdentures: Prosthetic Overview

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Abstract

Implant-supported overdentures are becoming the treatment of choice for the completely edentulous mandible. They significantly improve the quality of life in edentulous patients. For this review article, the literature was searched to identify pertinent studies. No meta-analysis was conducted because of high heterogeneity within the literature. Accordingly, in this review article, the author provides an update on implant-supported mandible overdentures with regard to the number of implants, type of loading, stress–strain distribution, mode of implant-to-denture attachment, occlusal considerations and complications.

Keywords: Dental implant, edentulous, overdentures, rehabilitation

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INTRODUCTION

Rehabilitating edentulous patients with residual ridge resorption has improved tremendously because of implant dentistry. Implant-supported overdentures have expanded rapidly as a successful treatment modality to rehabilitate completely edentulous patients. It improves retention, stability, function and esthetics as well as preserves the residual bone, especially in the mandible.^[1]

Many denture-related complaints associated with conventional dentures can be addressed when dental implants are used to retain conventional dentures.^[2] Overdentures are simply conventional dentures attached to the remaining teeth or dental implants.^[3] Several studies have indicated that the use of implant-supported overdentures in the mandible is an effective treatment modality,^[4,5] especially in patients with excessive loss

of residual bone.^[6] The survival rate of implants in the front region of the mandible is excellent, and the rate of surgical complications is very low. Moreover, implants demonstrate a reduced rate of residual ridge reduction in the anterior mandibular area.^[7] The treatment decisions depend on the patient's individual needs and treatment modalities together with their economic realities.

The treatment of choice between fixed and removable implant-supported overdentures varies across cultures and countries. The literature suggests that patients who receive removable implant-supported overdentures have significantly higher satisfaction with their overdentures than those treated with fixed implant-supported prostheses.^[8] Elderly people may have increased bone resorption, especially women after the age of menopause, and thus may have problems with denture use.^[9]

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In conventional complete dentures, continuous residual ridge resorption causes many problems including reduced retention, instability of dentures and soreness in the supporting mucosa owing to reduced denture-bearing area. The masticatory muscles in edentulous patients have diminished electromyographic activity and atrophy, which leads to weakened masticatory functional forces and reduced chewing.^[10] The maximum biting force of complete denture wearers is reduced to approximately 20% of dentate patients' biting forces. The reduced biting force alters masticatory functions because of inferior retention and stability of complete dentures. This will eventually lead to poor chewing ability in edentulous subjects.^[11,12]

IMPLANT TREATMENT OF AN EDENTULOUS MANDIBLE

The type of prosthetic constructions – and recently the advancement in implant-supported prostheses – is an important issue for oral health in elderly patients. Different studies have evaluated the high survival rates of implant-supporting overdentures. The overall survival rate is 95% in the maxillary arches and almost 100% in the mandibular arches.^[13]

The possibility of installing implants to support an overdenture can be assessed through panoramic radiographs. An edentulous jaw with variable anatomical features should be carefully studied to obtain more reliable radiological and clinical classifications for implant sites.^[14] The influence of smoking on the failure of implant treatment has been validated in many studies.^[15] Peri-implant diseases are more common in smokers because they have increased marginal bone loss.^[16] Further, diabetes has been established as a risk factor for failure of implants supporting an overdenture; however, the exact relationship is yet unknown.^[17]

Cardiovascular diseases are also a potential risk factor for marginal bone alterations.^[18] Some denture wearers cannot adapt to conventional dentures owing to their oral conditions, i.e., because of resorption of residual ridge and/or retention problems. When conventional denture wearers are compared with implant overdentures wearers, a significant improvement is seen in the patients' oral rehabilitation functions and satisfaction with mandibular arch implants.^[19,20] Implant-supported overdentures have an increased maximum biting force with an effective chewing efficiency.^[21,22] In addition, mandibular implants have a higher survival rate than maxillary implants, which may be due to the reduced mechanical forces that the maxilla has to resist because of its thinner cortical bone as well as the lower density of the maxillary spongy bone.^[23]

MANDIBULAR IMPLANT OVERDENTURES

Currently, implant-supported and implant-retained overdentures are an increasingly developed and predictable treatment modality for edentulous mandibles. The number of implants needed for a mandibular overdenture (usually two to four implants) is lesser than that required for a fixed implant prosthesis. This is an advantage because the volume of bone is reduced. Numerous long-term studies have confirmed that implant-supported overdentures provide satisfactory results with only two mandibular implants.^[24-26] Further, it is generally accepted that for an edentulous mandible, two implant-supported overdenture treatment is the standard of care rather than conventional denture treatment.^[27,28] In studies that compared different types of attachment systems in terms of retention, ease of use, hygiene and stability, it was found that the number of implants and the type of attachment system did not significantly affect patient's acceptance and satisfaction with mandibular overdentures.^[26,29]

Although evidence-based studies and reviews have shown that two implants are sufficient to support mandibular overdentures,^[30,31] more implants can make the attachment more rigid, which would help retain and stabilize the prosthesis. Accordingly, the use of four implants together with a bar attachment vastly increases the support of mandibular overdenture.^[32] However, it should be noted that the incidence of implant loss increases if the implants are ≤ 10 mm in length.^[33] This is possibly because thin implants inserted in the jawbone can lead to failed osseointegration.^[34]

The use of short implants in mandibles with marked bone resorption has been demonstrated to have good stability, high survival rates and minimal complications without the need for hospitalization.^[35] However, other studies have demonstrated that the use of mini-implants with immediate loading in the mandible with marked bone resorption shortens treatment time and improves overdenture stability, as evidenced in compromised geriatric patients.^[36]

Both splinted and nonsplinted implants resist the biomechanical requirements of early loading.^[37] Implants splinted together with a bar prevent implant micromotion and axial rotation.^[38] Other studies have suggested the use of fewer nonsplinted implants after an initial healing time of a few weeks. Thus, splinting of implants in the anterior area of the mandible is not an absolute necessity for successful osseointegration with different loading protocols.^[39] Therefore, the use of splinted or nonsplinted designs of implants that support an overdenture is not a

factor that affects the implant success and survival rate of peri-implant tissue.^[40]

LOADING OF IMPLANTS IN OVERDENTURE TREATMENT

Immediate loading (2–4 weeks after implantation) is acceptable following implant surgery if adequate implant stability has been achieved.^[41] Immediate loading without actual healing time following implant surgery can be achieved through four implants splinted together with a bar. Prosthetic clinical steps can be started immediately, following which patients can soon get their new implant-supported overdentures. This procedure significantly reduces the time of prosthetic rehabilitation and has positive results with high success rates.^[42,43]

The limitation of the immediate loading protocol is its use of long implants to achieve satisfactory primary stability because all four implants would be in the same vertical line. Short implants should be used when there is marked bone resorption, which necessitates a delayed loading concept with a suitable healing period. The survival rates of implants depend on the type of loading, i.e., immediate or conventional loading. Other factors include the number of implants that would support the overdenture, length of implants and splinting. A systematic review of loading options for implant-supported overdentures in edentulous jaws indicated that conventional loading protocols are more widely used than immediate loading, with minimal failure rates requiring fewer implants during the first year.^[44] The immediate two implant-supported overdenture loading protocol is less commonly used than conventional loading protocols.^[45,46] The immediate loading concept using two nonsplinted implants with mandibular overdenture not only achieves clinical and radiographic outcomes similar to that of conventional loading but also improves patient satisfaction. In the early loading protocol, using two implants to support a mandibular overdenture attains outcomes similar to that of conventional loading. However, there are insufficient data to conclude that early loading is linked to significantly higher patient satisfaction.^[41] Early loading is expressed in terms of success in bone functional quality as achieving an initial stability. The survival rates for early loaded implants are comparable with conventional loading concepts.^[47]

LOADING STRESS–STRAIN IN THE MANDIBLE: FINITE ELEMENT ANALYSIS

The distribution of stress–strain in the implant–bone interface and the bone of the basal seat of the overdenture has been studied in recent studies.^[48–51] These studies used

the three-dimensional finite element analysis to analyze this configuration, as it can explain the differences in stresses based on the type and design of attachments used in implant-supported overdentures. From these studies, it can be concluded that increasing the number of implants will decrease the stress at the implant and that stresses around the implants will be higher than the stresses on the bone.^[49,50] The highest stresses are measured at the cortical bone area, and the loading position or area on the dental arch is an important factor. Using the three-dimensional finite element analysis, it was found that in both the two and four implant-supported models, the first molar area is the most important loading area and it causes the highest stresses.^[50] Further, it has been shown that splinting of implants with a bar will induce a more desirable effect on the stress–strain distribution at the implant–bone interface.^[52] In contrast, inclination of an implant and misfit of overdenture components can result in higher stresses on the prosthesis and peri-implant tissues.^[51] Mesial inclination of the implant would increase the stress on the peri-implant tissues and in the prosthetic screws. On the other hand, distal inclination would decrease the stress as compared with parallel implants in the model. A round bar design would result in more compatible biomechanical function concomitant with less strain in the peri-implant tissues.^[53]

SPLINTING OF IMPLANTS WITH OVERDENTURES

The attachment system connects dental implants to overdentures either through splinting or nonsplinting of implants. The selection of attachment is determined by the desired degree of retention, anatomical bony status of residual alveolar ridge (anatomic situation of the mandible), interocclusal distance and parallelism of the implants together with hygiene.^[54,55] For an implant-supported overdenture to accept any attachment system, the degree of desirable retention, interimplant distance, maxilla–mandibular relation, status of the opposing arch and expected oral hygiene must be considered.^[56]

Implants supporting the overdenture can be splinted with a bar or an implant connection can be attained with individual connectors: ball or stud attachments and magnets. Splinting the implants together stabilizes the implants for better osseointegration. Supporting shorter implants in bone deficiency are better distributed in functional stresses.^[13] There are no statistically significant differences in implant failures between the various attachment approaches.^[13,57] The bar construction needs more vertical space to accommodate the attachment, whereas individual implants require lesser space.^[58] When

the implants are inserted in different bony areas, splinting with a straight bar is inconvenient, whereas attachments are easier to construct. Implant angulation may compromise the retention of attachments, but bar construction will resolve these problems. Technique and laboratory corrections, if any, of the ball attachment are simpler than that of the bar attachment. If the implant is deeply inserted into the alveolar bone, then locator abutment with variable heights is preferred over other abutments. The use of locator abutment can adjust retention because there are different inserts in the matrix. Magnetic attachments can be used when maximum retention is not needed. However, long-term use of magnetic attachments result in less retentive force than other attachment schemes.^[59,60]

PERI-IMPLANT TISSUE OUTCOME AND PROSTHETIC COMPLICATIONS

The prosthetic evaluation of implant-supported overdentures can be assessed with both clinical and radiological parameters as well as through retention, stability of the denture and breakage in the denture or implant attachments. On the other hand, implant success can be evaluated by assessing the health of the peri-implant tissues. The evaluation criteria include probing depth, bleeding index, plaque index, amount of attached mucosa surrounding the implants and possible exudates of pockets in the peri-implant tissues. In patients with proper oral hygiene, healthy marginal mucosa has been observed around the implants in the absence of keratinized mucosa.^[61,62]

There are biological and techno-mechanical complications encountered with implant overdentures. Mucosal hyperplasia is observed with bar attachments but not with ball attachments.^[2,63] Insufficient space under the bar would inhibit proper oral cleaning, which in turn could induce an inflammatory response in the soft tissues beneath the bar. In addition, in bar overdentures, the denture base settles less accurately on the mucosa as compared with that in ball overdentures. This reduced denture base settlement can, in turn, cause mucosal hyperplasia.^[63] Loosening of either the retentive mechanism or the occlusal screw with bars are the most common technical complications encountered with implant overdentures. Other common findings include fracture of the denture base material and/or retentive anchor as well as fractured bars.^[58] Rigid bar attachments may require proper tightening of the bar retainers, while resilient attachments may show loose or even broken female parts that would require repair and denture base relining. Over time, attachments will wear out and, consequently, the retentive force will be weak.^[64] Therefore, the adjustment

of overdentures after its insertion is periodically required for patients with this type of prosthesis. Bar-supported overdentures require fewer corrections and adjustments, whereas the other types of attachments require frequent prosthetic maintenance.^[40]

OCCLUSAL CONSIDERATIONS FOR IMPLANT-SUPPORTED OVERDENTURES

The well-known occlusal concepts are instituted through clinical trials and produce maximum intercuspation during centric occlusion. There are three occlusal concepts, namely, balanced, group function and mutually protected occlusion. These may be modified for implant-supported overdentures.^[65,66] However, there have been studies where the authors considered different occlusal schemes to be less important in treatment outcomes measured using clinical and radiographic data. The most important factor is improvement of tooth morphology to minimize the biomechanical risk factors in the implant-supported overdenture.^[67] Crestal bone resorption and the eventual loss of osseointegrated implants can be due to an excessive occlusal overload. Therefore, occlusal overload due to excessive lateral stresses is an important factor responsible for marginal bone resorption and implant failure.^[68,69]

Implants are ankylosed elements in the surrounding bone without natural periodontal ligament, and they lack shock absorbing effects and mechanoreceptors. An important cause for failure of an implant-supported overdenture is the occlusal overload, which is also responsible for the peri-implant bone loss. Implant overload can cause clinical issues such as overdenture fracture, implant fracture or implant loss following marginal bone loss. These issues can be controlled by passive fitting the overdenture, reducing cusp inclination and removing excursive contacts. Further, the type of overdenture can be changed and more implants can be added to control biomechanical complications.^[70]

CONCLUSION

The retention and stability of conventional complete dentures is more of a concern in the mandible than in the maxilla. This is primarily attributed to the reduced surface area for support and retention in the mandibular arch. Therefore, implant-supported overdentures are a predictable treatment option for completely edentulous mandibles. This treatment modality improves the quality of life in edentulous patients. Although dental implants can be immediately loaded if attachment points are stable, the conventional loading protocol is more commonly used. Two dental implants to support the mandibular overdenture are considered sufficient to provide the

required stability and retention of the denture. It is imperative that the overdenture has a passive fit without any occlusal interferences to avoid overloading the dental implants, which could cause clinical complications such as overdenture fracture, implant fracture or implant loss.

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Conflicts of interest

There are no conflicts of interest.

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