



Basic Principles for Implant Supported Overdentures

D. Papalexopoulos ^{a*}, T. K. Samartzi ^b, A. Pachiou ^a, K. Konstantopoulou ^a,
P. Tsirogiannis ^a and N. Sykaras ^a

^a Department of Prosthodontics, National and Kapodistrian University of Athens, Thivon 2, Athens, Greece.

^b Private Practice, Thivon 2, Athens, Greece.

Authors' contributions

This work was carried out in collaboration among all authors. Authors DP and TKS designed the study, co-wrote the manuscript. Author AP made the first revisions of the manuscript. Author KK managed references of the manuscript. Author PT In charge of English language editing, provided the figures of the manuscript. Author NS supervisor, made the final revisions. All authors read and approved the final manuscript.

Article Information

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/85256>

Systematic Review Article

Received 02 February 2022

Accepted 11 April 2022

Published 16 April 2022

ABSTRACT

Aims: Implant supported overdentures combine the retention and support provided by implants with the advantages of removable prostheses and demand careful preoperative planning. The aim of the present article is to provide a clinically based rationale while designing or fabricating such a rehabilitation.

Methodology: In order to conduct this narrative review, evidence based research articles regarding implant supported overdentures published from January 1990 until December 2020 were searched via the MEDLINE (Pubmed) database. The keywords used were “overdentures”, “implant overdentures”, “implant supported overdentures”, “implant retained overdentures”, “implant assisted overdentures”.

Results: Implant supported overdentures have high success rates and compared to conventional ones they provide superior quality of life, well-being, satisfaction and adequate masticatory efficiency. A crucial factor that should be determined preoperatively is the number and position of implants that need to be placed. Preoperative three-dimensional assessment is of utmost importance to avoid mistakes like the construction of bulky restorations or the absence of adequate

[‡]Assistant Professor;

*Corresponding author: Email: dimpapalex@hotmail.com;

material in crucial areas of the restoration with the subsequent acrylic tooth/connector detachment and aesthetic compromise. Selection of the appropriate retentive system depends on the number and the distribution of implants, the desired retention, the morphology of the ridge, the intermaxillary relation, the available prosthetic space, the vertical and horizontal dimensions, the patient's needs and desires, the oral hygiene and the cost. Special care should be given to impression making procedures as well as framework design and fabrication. If the abovementioned are taken into account, subsequent complications are reduced. However, frequent maintenance appointments should be scheduled.

Conclusion: Several concerns arise when choosing an implant supported overdenture that mainly refer to the special characteristics defining its function. The key element is the careful preoperative planning of the restoration since it affects the long-term behavior of the prosthesis in terms of technical and biological complications and the frequency of the clinicians reinterventions.

Keywords: Implants; overdentures; removable.

1. INTRODUCTION

Edentulism emerges as a result of periodontal disease, caries or trauma. Resorption of residual ridges, deterioration of masticatory ability, impairment of phonetics and aesthetics, as well as the subsequent psychological burden are some of the negative impacts of tooth loss [1]. This condition has been connected with well-documented consequences upon general health and oral health related quality of life [1].

Rehabilitation of completely edentulous patients has always been a clinical challenge for the dentist who needs to find the most appropriate individualized prosthetic approach for the patient via a well-structured diagnostic process. This includes a thorough clinical and radiographic examination combined with data analysis from patient's medical and dental history along with their demands and desires consideration.

Conventional rehabilitation of edentulous arches can be accomplished with removable complete dentures. Improvement in the field of implantology has made implant-supported removable or fixed prostheses an additional therapeutic option. Lack of adequate retention and stability, pain and discomfort that are sometimes associated with mandibular complete dentures have led to the suggestion of a two-implant-retained mandibular overdenture as the first choice for the rehabilitation of the lower jaw [2]. There are also patients experiencing great adaptive difficulties functionally and psychosocially concerning the conventional dentures and this may influence the option for dental implant therapy [3].

Stability and resemblance with the natural dentition provided by fixed prostheses, renders

them an appealing alternative. However, anatomical limitations affecting implant number and distribution, jaw anatomy influencing the lip and facial muscles support, together with patient's needs and financial restrictions make removable prostheses a considerable option. Financial parameters need to be taken into consideration, since a mandibular overdenture appears to be more cost-effective than the fixed implant treatments plans for edentulous patients [4].

Mandibular implant-retained overdentures are assessed with higher patient satisfaction, better quality of life and mastication by approximately 33% when comparing them to conventional complete dentures in edentulous patients [5]. There are also patients experiencing great adaptive difficulties concerning the conventional The functional and psychosocial disability experienced by the non-adaptative denture patient may influence the option for dental implant therapy and prosthetic rehabilitation

The progress achieved in dental implants has also improved the overdenture attachment systems so that problems associated with prostheses could be overcome over the recent years with a variety of available attachment solutions, making it sometimes hard for the clinician to choose the most appropriate option [6].

The aim of the present review is to present clinical-based guidelines regarding advantages, treatment plan considerations, prosthesis design, techniques and materials for fabrication and maintenance of implant-supported overdentures.

2. MATERIALS AND METHODS

In order to conduct this narrative review, evidence based research articles regarding implant supported overdentures published from January 1990 until December 2020 were searched via the MEDLINE (Pubmed) database.

The keywords used were “overdentures”, “implant overdentures”, “implant supported overdentures”, “implant retained overdentures”, “implant assisted overdentures”.

Articles written in English, peer-reviewed articles and articles elaborating on any aspect regarding the preoperative plan, design, fabrication, indications, advantages, maintenance and complications of implant supported overdentures were set as the inclusion criteria. Duplicates, and articles not focusing on aspects of the rehabilitation with implant supported overdentures were excluded.

3. RESULTS

Initial search yielded 3,307 records. After exclusion of duplicate articles, two reviewers (D.P. and T.K.S.) evaluated the remaining articles by a gradual screening of titles, abstracts and full texts. The same reviewers proceeded to the extraction of relevant data. Available information were grouped and classified into five thematic groups dealing with the:

- Comparison between implant supported overdentures and conventional dentures or implant supported fixed full-arch prostheses
- Factors that should be considered while planning the treatment
- Considerations regarding the selection of retentive attachment type
- Clinical guidelines for the fabrication of implant supported overdentures
- Information regarding maintenance, technical and biological complications

3.1 Implant Supported Overdentures vs Complete Dentures or Fixed Implant Supported Prostheses

Implant supported overdentures have high success rates (>90%) [7] and compared to conventional ones they provide superior quality of life, well-being [8], satisfaction [9] and adequate masticatory efficiency [10]. According

to McGill’s and York’s consensus reports, an overdenture supported by two implants is the gold standard for the rehabilitation of the edentulous mandible [2,11].

Compared to fixed prostheses, removable restorations require a reduced number of implants and fewer pre-prosthetic interventions, while they facilitate oral hygiene and repairs. Correction of an unfavorable intermaxillary relationship becomes simpler, while the facial appearance may be superior, due to the supportive presence of flanges [12,13]. It has been demonstrated that there is no substantial difference in masticatory efficiency among fixed and removable restorations [14]. Lastly it is not mandatory for implant positions to accurately coincide with tooth positions.

3.2 Preoperative Planning – Number and Position of Implants

Implant overdentures are supported by implants and soft tissues while the retention is provided by the retentive elements of the attachments. Implant number and spread are crucial factors affecting the function of the prosthesis. The use of a reduced number of implants leads to a mixed or mucosal support that may lead to an accelerated wear rate of the connectors. On the other hand, a greater number of implants placed over a larger area, creates more rotational axes that prevent denture rotational movements and detachment offering a more “stable” behavior that resembles fixed prosthesis.

Therefore, a crucial factor that should be determined preoperatively is the number of implants that need to be placed. According to the literature, this aspect is more important than the diameter of the implants chosen [15]. Even though there is consensus for the mandible (2 implants), controversy exists among the authors for the maxilla; however, a minimum of 4 implants are commonly suggested [16-18].

A significant aspect that also needs to be considered is the position of the implants placed. From a biomechanical point of view the most favorable positions for the anterior region is between lateral incisors and canines (22mm between the 2 mandibular implants [19]), (Fig. 1) and for the posterior region at the second premolar. Implant inclinations and distribution are among the factors that will determine the freestanding or connected design of the retentive mechanisms [20].

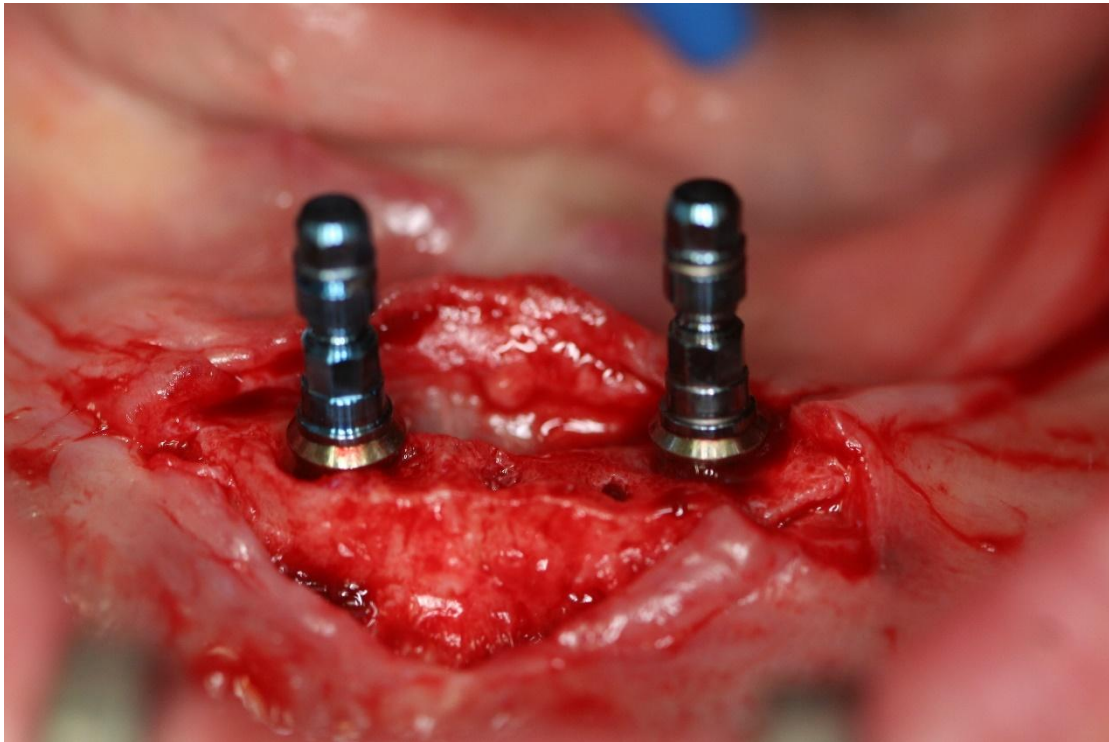


Fig. 1. Two implants placed in the position of lateral incisors in the mandible.

Implant positions should not necessarily coincide with the position of the teeth in this kind of prostheses. However, careful planning should offer the possibility for a future upgrade of the existing prosthesis.

Preoperative three-dimensional assessment is of utmost importance to avoid mistakes like the construction of bulky restorations or the absence of adequate material in crucial areas of the restoration with the subsequent acrylic tooth/connector detachment and aesthetic compromise. This is achieved via cast articulation in central relationship and in the appropriate vertical dimension. Diagnostic set-ups or the use of correctly fabricated dentures allows the assessment of the available space in relation to the connectors with the use of indexes [21].

3.3 Bars Vs Stud Attachments

Selection of the appropriate retentive system depends on the number and the distribution of implants, the desired retention, the morphology of the ridge, the intermaxillary relation, the available prosthetic space, the vertical and horizontal dimensions, the patient's needs and desires, the oral hygiene and the cost [22].

Regarding the attachments, utilization of a bar requires a vertical space of 13-14 mm while stud attachments offer the potential of rehabilitation in a more limited space (9-12 mm) [23]. However, removable prostheses offer the opportunity of modest alterations of the vertical dimension in order to ensure the desired space in cases of small deficiencies. The horizontal dimension should also be measured since there are some designs like the Hader bar that demand 10-12 mm of space [24].

Some of the commonly used stud attachments, have the advantage of double retention in the inner and outer surface of the stable part of the attachment, they can guide insertion, they respond well to cyclic loading that exceed 60.000 insertion circles -equivalent to 10 years of function-, have the potential of selection of the desired retention, as well as easy replacement when wear emerges [25].

Compared to bars, stud attachments provide more easily accessible and efficient oral hygiene because of their lower height. It is suggested to begin with a retentive nylon insert of reduced retentive strength and to gradually increase it according to patient's capability and demands [26]. The aforementioned choice should be customized to each patient, as a geriatric,

probably frail, patient with reduced tactile sensitivity should not be treated as a younger, robust patient.

Bars seem to provide better retention than stud attachments with no impact on patient's satisfaction. Moreover, they offer implant splinting and better stress distribution. The former has been suggested when a prosthesis without palate coverage is desired. It should be mentioned though that in case of absence of palate coverage, implant survival rates do not decrease [27].

Different bar designs offer different rotation and biomechanic performance of the prosthesis. A round cross-section bar provides greater rotation compared to a Dolder or Hader bar. Orientation at the transversal plane also defines the existence of rotational movements. Another benefit of a splinted design is the incorporation of retentive components in locations that do not coincide with implant positions (Fig. 2). This feature offers the advantage of correcting the dispersion of the retentive elements while incorporating implants not placed in ideal positions.

Except for the greater prosthetic space requirements, restorations with a bar are more demanding in terms of design, technical sensitivity, fabrication methods and cost. Impressions should be made utilizing techniques

and materials that ensure dimensional accuracy. Impression accuracy should be verified with a jig that is constructed on the final cast and tried intraorally [28].

3.4 Overdenture Fabrication Guidelines

Impression making is a crucial step of the fabrication process, in order to precisely transfer the three dimensional position of the implants to the dental laboratory. According to the literature, the open tray technique with splinted impression posts is the most accurate technique regarding conventional impressions [29], especially in cases of non-parallel implants [30]. Nevertheless, precise implant position transfer should not be done in expense of soft tissue impression accuracy, following the principles of conventional dentures. A variety of techniques is available in order to combine the two abovementioned prerequisites [31]. Wax rims with baseplates that can be screwed in one of the placed implants facilitates the intermaxillary record procedure (Fig. 3).

Fabrication of bars is a technique-sensitive procedure. They should be parallel to the condyles hinge axis and offer a space of 1,5 mm between their lower surface and patient's mucosa. Their extensions should not exceed 10mm. It has been demonstrated that extension from 10 to 20mm increases stresses for about 110% [32].

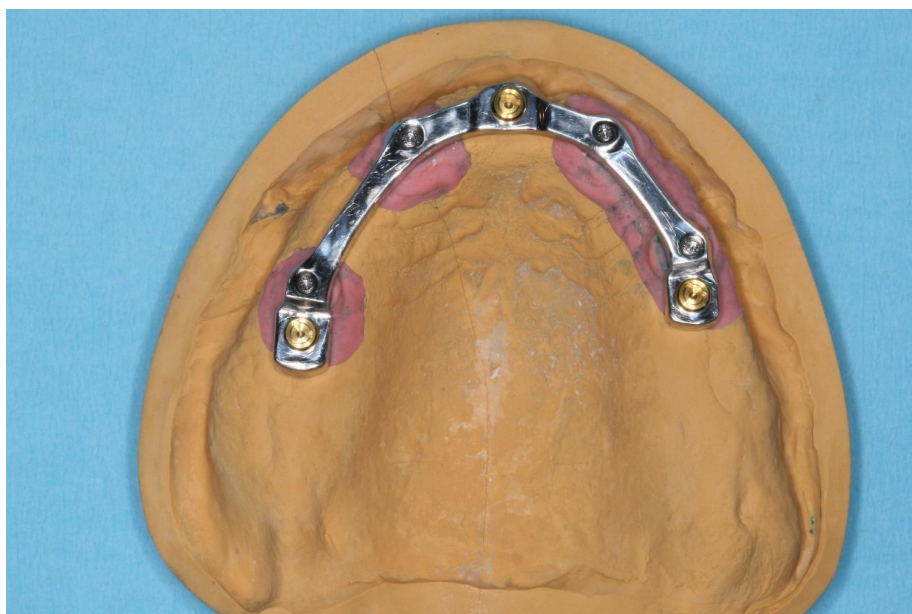


Fig. 2. Bar design with incorporated stud attachments placed at positions that do not coincide with implants

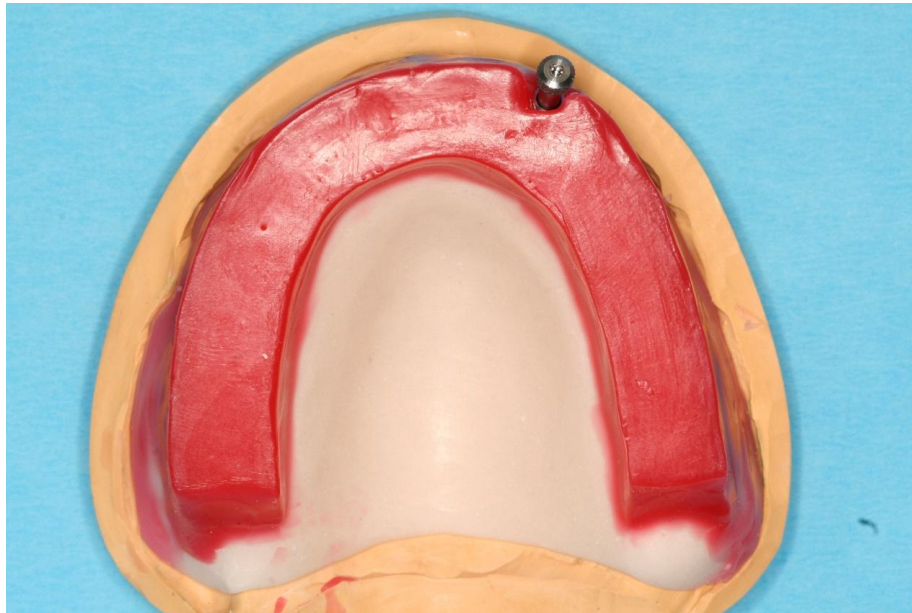


Fig. 3. Using one implant for baseplate stabilization enhances the accuracy of the record by eliminating wax rim micromovements

CAD/CAM technologies are applied for the construction of the bar and the framework of the prosthesis as well, with either additive or subtractive methods [33]. Innovative technologies and techniques that combine polymer bars (PEEK) with zirconia frameworks have emerged. However, long-term studies are required to verify their clinical behavior [34].

To avoid deformation the nylon inserts of the attachment should be incorporated into the prefabricated metal housing and not directly in the acrylic or an extension of the metal framework. Careful design should offer enough space during activation so that the metal housings are surrounded by acrylic, making reinterventions easier. Attachment activation is suggested to take place intraorally. should be placed to avoid acrylic overflow.

3.5 Complications

Complications that need repair concern the replacement of the attachments, denture relines, replacement of the acrylic teeth and they usually appear within the first year of function [22]. Some authors claim that complications are more frequent in case of stud attachments than bars [35].

Regarding biological complications there is no difference in periimplant indexes among bars and stud attachments. Prosthetic design, bone

substrate and arch morphology are more crucial factors [12]. Hyperplasia due to poor oral hygiene and negative pressure is a common complication in bars [36].

In any case, when the treatment plan includes implant supported overdentures, patients should be informed that frequent recalls are needed. According to a study, within 10 years after restoration delivery more than 443 minutes are dedicated to intervention/repairs [37].

4. DISCUSSION

Even though the initial costs are high, rehabilitation of edentulism with implant supported prostheses results in improvement of oral health related quality of life (OHRQoL) [38]. Implant supported overdentures comprise a restorative solution that combines improved function [10] compared to conventional dentures and lower costs and surgical interventions as opposed to full-arch implant retained fixed prostheses. The aforementioned can be justified by the McGill consensus according to which an implant supported mandibular overdenture should be the minimum standard offered to an edentulous patient [2].

In order to further simplify both the treatment plan and surgical procedures and reduce costs for patients in developing countries [39] the concept of a single-implant retained overdenture

has been proposed for the mandible [40]. Based on a recent systematic review and meta-analysis there are no differences between one and two implant supported overdentures regarding prosthetic complications, oral health related quality of life and marginal bone loss after five years in function [41]. According to the same authors this treatment modality has the potential to become the new minimum standard.

On the other hand, innovative technologies and materials have been incorporated into the implant supported overdenture fabrication protocol. Obtaining a virtual version of the patient [42] is nowadays feasible due to the synergic utilization and superimposition of both intraoral [43] and facial scanners [44] and cone beam computed tomography [45] via special softwares. These softwares simplify the procedures of treatment plan and design of appliances such as surgical templates [46] that aid during implant placement or replicas for the confirmation of the impression accuracy and can be fabricated either by milling or 3D printing techniques.

At the time being literature does not support the use of intraoral scanners in completely edentulous patients [47]. However, these data are based on first generation scanners while the technologies evolve with a rapid pace and different intraoral scanners perform differently in terms of accuracy. [48] Some recently published studies have reported fabrication of bars for implant supported overdentures with the combination of intraoral scanners and CAD/CAM technologies [49].

New technologies have also made possible the use of materials that are more aesthetic than metal alloys, such as polyether ether ketone (PEEK). PEEK is a biocompatible, non-allergic, rigid, radiolucent, white polymer with low plaque affinity [50] and elastic modulus that is close to human bone [51]. Some recent studies have reported on the use of PEEK as a bar fabrication material with promising results [42] that must be further investigated. Another aesthetic material incorporated in many dental application is zirconia [52], a biocompatible ceramic material with wear resistance and high mechanical properties. According to a crossover study patient satisfaction was superior with zirconia than cobalt-chromium bars in terms of psychological preference, appearance, time, hygiene, undergo procedures, recommend procedures and the overall experience [53].

5. CONCLUSION

Several concerns arise when choosing an implant supported overdenture that mainly refer to the special characteristics defining its function. The key element is the careful preoperative planning of the restoration since it affects the long-term behavior of the prosthesis in terms of technical and biological complications and the frequency of the clinicians reinterventions.

CONSENT

It's not applicable.

ETHICAL APPROVAL

It's not applicable.

ACKNOWLEDGEMENTS

A brief acknowledgement section may be given after the conclusion section just before the references. The acknowledgments of people who provided assistance in manuscript preparation, funding for research, etc. should be listed in this section. All sources of funding should be declared as an acknowledgement. Authors should declare the role of funding agency, if any, in the study design, collection, analysis and interpretation of data; in the writing of the manuscript. If the study sponsors had no such involvement, the authors should so state.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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