

A Comparison Between Fixed and Removable Mandibular Implant-Supported Full-Arch Prostheses: An Overview of Systematic Reviews

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Purpose: To evaluate the current literature and provide clinical recommendations related to the number of implants, implant characteristics, loading protocols, survival rates, biologic and mechanical complications, patient satisfaction, and financial considerations for mandibular implant-supported full-arch prostheses.

Materials and Methods: A PubMed/MEDLINE search for literature published between January 1, 1980 and February 8, 2019, was performed for systematic reviews on this topic. The PICO question was: In mandibular fully edentulous patients treated with implant full-arch prostheses, is there any difference between fixed and removable implant prostheses in terms of implant and prosthesis survival rates? Only systematic reviews with or without meta-analyses were included. The findings varied based on the type of implant full-arch prosthesis.

Results: High survival rates for implants and prostheses have been reported for fixed and removable implant full-arch prostheses in the mandible. Immediate loading procedures present with high survival rates for both fixed and removable prostheses. There are differences in the number of implants, implant characteristics, complications, and financial implications between these two types of prostheses, which clinicians need to account for as part of the treatment planning process. **Conclusion:** Implant-supported overdentures and implant-supported fixed complete dentures represent clinically successful treatment approaches. In cases where both treatment options are indicated, patient expectations and cost should be the determining factors for selecting a treatment modality. *Int J Prosthodont* 2021;34(suppl):s85–s92. doi: 10.11607/ijp.6911

Epidemiologic studies have shown that, although the incidence of complete edentulism has decreased, the number of patients in need of treatment is projected to increase due to population growth, greater life expectancy, and lower overall burden of dental disease.^{1–3} For completely edentulous patients, reported data indicate that the use of dental implants is constantly increasing.^{4–6} This means that there will be a significant number of completely edentulous individuals to treat with implant-supported prostheses in the future.

The prosthetic options for completely edentulous patients range from conventional complete dentures to implant-supported overdentures (IOVDs) and implant fixed complete dentures (IFCDs). Regardless of the treatment choice, the definitive treatment plan should be based on a sound and evidence-based prosthetic and surgical rationale. Prosthetic factors to be considered during treatment planning may include, but are not limited to, lip support, smile line, vertical dimension of occlusion, phonetics, and esthetics, while surgical factors include the available bone, the need for grafting, the quality of bone, and certain anatomical limitations, such as the presence of a lingual concavity or sinus cavities and the proximity to vital structures.⁷

Several differences exist between fixed and removable implant prosthetic options. Patients tend to be more satisfied with fixed implant prostheses because they are characterized by better stability and retention while covering less tissue, feel more comfortable for the patient, and better simulate the natural dentition.⁷ On the other hand, IOVDs cause fewer phonetic problems and reduce the treatment time and overall surgical morbidity in cases with severely resorbed ridges when major grafting

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procedures are required. Finally, the cost associated with IOVDs is significantly less than IFCDs.⁷

A number of implant treatment options have been described in the literature, with variations in the implant number, length, diameter, inclination, and position for completely edentulous patients.⁸ Implant number and location can vary and should always be based on a plan that includes a favorable prosthodontic arrangement, as well as the recognition of anatomical and surgical limitations. In IFCDs, the anterior-posterior spread is also very important, as this mainly dictates the length of the cantilever extension.⁹

Several protocols including surgical and prosthodontic considerations have been reported in the literature for the edentulous mandible.¹⁰ Choosing the most appropriate protocol represents a challenge and should rely on evidence-based approaches.⁴ Clinicians should know the incidence and types of mechanical and biologic complications, implant and prosthesis survival rates, success of different loading protocols, minimum required number of implants per prosthesis, and patient-reported outcome measures (PROMs), as well as the financial implications with either prosthesis.

The purpose of this literature review was to evaluate the current evidence related to the number of implants, implant characteristics (short, narrow, and regular size), loading protocols, survival, complications (mechanical and biologic), PROMs, and financial considerations for mandibular implant-supported full-arch prostheses.

MATERIALS AND METHODS

This article is an overview of systematic reviews published between January 1, 1980, and March 8, 2019. The literature was searched in order to identify the differences between mandibular IOVDs and IFCDs in terms of number of implants, survival of implants and prostheses, complication rates, implant characteristics, PROMs, and financial implications. The search on PubMed/Medline comprised a combination of medical subject headings (MeSH) and free text terms and were: mandible; implant fixed complete denture; implant fixed complete dental prosthesis; implant overdenture; implant removable complete denture; patient satisfaction; patient-reported outcome measure; PROM; mechanical complications; biologic complications; financial implications; implant number; implant diameter; narrow implants; and short implants. Systematic reviews in the English language were included in the final analysis. All other types of studies were excluded. Articles containing information for the below factors were selected and read in detail by two authors (A.T. and K.C.):

- Number of implants
- Short- vs standard-length implants

- Narrow- vs regular-diameter implants
- Loading protocols
- Prosthodontic and implant survival rates
- Mechanical and biologic complications
- PROMs
- Financial implications

The included systematic reviews were analyzed, and definitive conclusions and recommendations were made whenever possible. In case systematic review evidence was lacking, no conclusions or recommendations were made.

RESULTS

The previously mentioned factors for IFCDs and IOVDs were identified in the included studies and are presented below. Whenever there was not a study reporting these factors for both maxillary and mandibular prostheses in the same cohort of participants, the findings were reported separately for each prosthesis design.

Number of Implants

A total of 12 systematic reviews reporting the number of implants used were included.^{4,11–21}

Mandibular IFCDs

A systematic review published in 2014 reported that the number of implants for mandibular IFCDs ranged from four to nine.⁴ The most common distribution of implants was interforaminal placement (88.5% of all implants). This review concluded that implant survival was not affected by either the number of implants or the anterior-posterior implant distribution.⁴

According to a more recent systematic review, a large number of studies reporting high survival rates with mandibular IFCDs supported by four implants was identified.¹¹ A limited number of studies suggested the use of three or even two implants in order to minimize the overall cost and make this treatment option more affordable for a greater number of patients.^{14,15} At this point, it is critical to note that studies suggesting the use of two implants for this prosthetic option are limited, have short follow-up times, and are mainly generated by the same research group, which increases the risk of bias. Similarly, good survival rates have been reported by the use of a three-implant-supported fixed complete denture, but the follow-up period was too short to make any definitive conclusions. On the other hand, it remains unclear whether there is a specific indication for six or more implants for mandibular IFCDs.

When evaluating whether there is a difference in implant or prosthesis survival rates between the use of fewer or more than five implants in mandibular IFCDs, no statistically significant difference was reported, with implant survival rates ranging from 95% to 98% and

prosthesis survival rates ranging from 97% to 99%, with a follow-up time ranging between 1 and 5.5 years.¹¹ When three-implant FCDs were compared to four- and five-implant FCDs, the three-implant mandibular FCDs presented with inferior survival rates compared to the four- and five-implant prostheses.¹² In conclusion, a minimum number of four implants should be used for mandibular IFCDs, with the most commonly reported range being four to six.¹³

Mandibular IOVDs

A systematic review that was published in 2016 concluded that there was no significant difference between one- and two-implant mandibular OVDs and that more studies are needed in order to draw more definitive conclusions.¹⁷ Another systematic review, which was published later, concluded that, when mandibular IOVDs are used, clinicians might choose to place either two or four implants.²¹ These implants may be either connected to individual attachments or be associated with prosthetic frameworks (bars) or telescopic crowns.¹⁹ In another systematic review, the four-implant OVDs showed better survival and success rates compared to two-implant OVDs.¹⁸ One-implant OVDs presented with significantly higher implant loss than two-implant OVDs, while two-implant OVDs presented significantly higher implant loss than four-implant OVDs.²¹

Short-Length and Narrow-Diameter Implants

A total of 10 systematic reviews on short-length and narrow-diameter implants were found.^{16,22–30}

Mandibular IFCDs

Several studies consider implants to be short dental implants if their length is < 10 mm,²⁴ while other studies consider short to be a length of ≤ 8 mm.²³ Short dental implants may provide an alternative treatment option in patients with atrophic edentulous areas who either do not have the financial resources or do not wish to proceed with extensive augmentation procedures.²³ The question is whether short implants supporting a mandibular IFCD are equally successful as standard-size implants placed in augmented bone.

Three systematic reviews on this topic have been included.^{22–24} Two of these systematic reviews evaluated both partially and completely edentulous patients in both maxillary and mandibular arches.^{22,24} Due to a lack of studies reporting the success of implants placed only in the mandible, it was not possible to separately evaluate the efficacy of short implants in the mandible. A recent systematic review and meta-analysis focused specifically on full-arch mandibular prostheses with short implants, reporting a 34.5% prevalence of prosthetic complications, 98% implant survival rate, and 0.11 mm of marginal bone loss with a mean follow-up of 12 months.²³ In summary, mandibular IFCDs supported exclusively by short dental implants may be a viable

treatment option, but there is insufficient evidence for definitive conclusions.

For IFCDs, narrow dental implants with a diameter of < 3.5 mm have been used mainly for the rehabilitation of the atrophic edentulous mandible and have performed statistically worse than standard-size implants, according to Schiegnitz.²⁹ The evidence is still scarce on the survival of narrow-diameter implants supporting full-arch prostheses, and more long-term data are needed for definitive conclusions.²¹ Presently, there is no study with a high level of evidence evaluating the clinical performance of mandibular IFCDs supported by narrow-diameter implants. Therefore, no clinical recommendation can be made for exclusively narrow-diameter implant mandibular IFCDs.

Mandibular IOVDs

An RCT with 50 patients compared mandibular, immediately loaded, four–mini-implant OVDs to two standard-size–implant OVDs. After 1 year of follow-up, there were no statistically significant differences in marginal bone loss, survival rates, or patient satisfaction.³¹ This result is in accordance with the systematic review published by Park et al,²⁷ where mini-implants supporting mandibular OVDs provided high survival rates as well as patient satisfaction and optimal marginal bone loss patterns. Two other systematic reviews evaluated mandibular overdentures retained by mini-implants.^{25,28} Both of these reviews concluded that mini-implants can be a viable option for supporting mandibular OVDs.

Another systematic review evaluated clinical and radiographic outcomes and the success and survival rates of mini-implant (1.8 to 2.9 mm) mandibular IOVDs compared to narrow-diameter (3 to 3.5 mm) IOVDs.²⁶ There was no statistically significant difference in either the survival or success rates between the two groups. However, the group with the mini-implants showed more bone loss and worse long-term predictability. Both mini-implants and narrow-diameter implants showed adequate clinical behavior as OVD retainers.²⁶

Loading Protocols

A total of seven systematic reviews on loading protocols were included.^{4,11,21,32–35}

Mandibular IFCDs

Immediate (within 1 week), early (1 week to 2 months), and conventional (> 2 months) loading protocols for IFCDs have been reported with predictable and successful outcomes.^{4,10,21,32} In a recent systematic review comparing immediate vs conventional loading of IFCDs, no significant differences in either implant or prosthesis survival rates were found after a mean follow-up time of 5.5 years.¹¹ In the same study, even after comparing IFCDs supported by fewer than five implants to those supported by more than five implants, no significant

differences were recorded between different loading protocols.¹¹ Similarly, another study reported high survival rates for immediately loaded mandibular IFCDs.³⁶ Along the same line are results from another systematic review, with a 100% cumulative estimated implant survival at 10 years in mandibular IFCDs, which were either immediately or early loaded.⁴ The mandibular IFCDs that were loaded conventionally presented with a 97.08% cumulative survival rate at 10 years. This meta-analysis concluded that for the mandibular IFCDs, there was no influence of loading protocol on prosthesis survival at 5- and 10-year endpoints.⁴

Mandibular IOVDs

A systematic review and meta-analysis on loading protocols in mandibular and maxillary IOVDs was published in 2014.³³ Even though this systematic review included both edentulous arches, comparative studies were only available for mandibular IOVDs. Although all three loading protocols provided high survival rates, early and conventional loading protocols were still better documented than immediate loading. Other systematic reviews support similarly successful outcomes for mandibular overdentures.^{34,35} Additionally, the Camlog Foundation Consensus Report concluded that there is no increased risk for implant loss with immediately loaded implants compared to conventionally loaded implants in mandibular IOVDs.^{21,36}

Prosthetic and Implant Survival Rates

A total of five systematic reviews were included on this topic.^{4,18,37–39}

Mandibular IFCDs

IFCDs represent a clinically documented sound treatment approach for both arches. Numerous studies with at least 5 years of follow-up report high implant and prosthetic survival rates.^{4,37,38} One study reported 95.5% and 100% prosthesis and implant survival rates, respectively, for mandibular IFCDs, while the overall success rate was 86.7% for 5 years.³⁷ In another systematic review, similar rates were reported for an overall 10-year follow-up period, with 97.25% prosthetic survival and 96.8% implant survival.³⁸

Mandibular IOVDs

Clinical studies on mandibular IOVDs present high implant survival rates ranging from 95% to 97.4% at 5 years.^{40,41} The survival of IOVD prostheses has also been high, ranging from 97.7% at 10 years for four-implant/bar OVDs to 98.8% at 10 years for two-implant/ball attachment OVDs.⁴² Two systematic reviews confirmed these successful outcomes for mandibular implant overdentures.^{18,39}

Mechanical and Biologic Complications

Three systematic reviews on mechanical and biologic complications were included.^{38,43,44}

Mandibular IFCDs

There is scarce evidence reporting on mechanical and biologic complication rates for IFCDs for an observation period of more than 5 years.^{38,45} In addition, most studies do not separately report complications between maxillary and mandibular IFCDs. One study compared 25 mandibular IOVDs to 25 mandibular IFCDs in terms of survival and complication rates at 5 years of follow-up.⁴⁶ This study concluded that in the first year after delivery of the definitive prostheses, the IOVDs presented with more complications compared to IFCDs (2.27 recalls for IOVDs vs 1.57 recalls for IFCDs). However, after the first year, the IFCDs required more maintenance. The most common complications were peri-implant mucositis, abutment and screw repairs, acrylic resin fractures, and retentive clip repairs. It was concluded that IOVDs offer a good alternative to IFCDs for the mandible.

Results from 45 mandibular IFCDs and a total of 237 implants (a range of 4 to 6 implants per prosthesis) were reported in 2019.³⁷ Most of the observed complications were technical in nature, with the most common being fracture of the acrylic resin teeth and bases (20/54). These results were confirmed by another systematic review³⁸ showing that technical complications were more common than biologic. The most common technical complication in this study was the fracture of the veneering material (33% at 5 years), while the most common biologic complication was more than 2 mm of implant bone loss (20.1% at 5 years).

Mandibular IOVDs

Even though high implant and prosthetic survival rates have been reported for IOVDs, mechanical and biologic complications are unavoidable. Two studies reported that most of the mechanical complications were associated with reactivation of attachments (53%), followed by a need for relines (26%).^{43,44} The most common biologic complication was the high incidence of mucosal hyperplasia (31%).

Patient-Reported Outcome Measures

Two systematic reviews on PROMs were included.^{47,48}

Limited evidence exists in regard to patient-centered outcomes for mandibular full-arch prostheses. Most of the studies for IOVDs and IFCDs report results for survival and complication rates without presenting data on PROMs.⁴⁹

A recent systematic review⁴⁷ reported on PROM differences between IOVDs and IFCDs. No statistically significant differences were found between the two prostheses. Four studies reported exclusively on mandibular prostheses.^{50–53} Two of these studies reported significantly better chewing ability with IFCDs compared to IOVDs.⁵³ In one of these studies, the mandibular IFCDs were rated significantly higher in patient satisfaction compared to the other three studies,

where no statistically significant difference was noted.⁵² Similar results were reported in a crossover trial, where the IFCDs presented with statistically significantly higher stability and chewing ability, while the IOVDs presented with statistically significantly better oral hygiene.⁵⁴

In 2018, the 6th International Team for Implantology (ITI) consensus conference reported on PROMS for IOVDs and IFCDs.⁴⁷ According to the consensus, there are currently no guidelines on the most appropriate PROMs in implant dentistry. Based on this consensus, there was no difference between IOVDs and IFCDs except for oral hygiene maintenance, which was significantly easier with IOVDs. Another systematic review concluded that mandibular IOVDs increase patient satisfaction for edentulous people when compared to conventional complete dentures, but all other types of prosthesis comparisons are underexposed to research.⁴⁸

Financial Implications

One of the main parameters that affect whether patients will agree to proceed with an implant-supported fixed vs removable complete denture is the financial cost of each treatment option in the short and long term. No systematic reviews were identified to directly compare the cost-effectiveness between full-arch fixed vs removable prostheses in the mandible.

One study compared the financial implications between implant-retained fixed and removable mandibular prostheses over 4 to 6 years.⁵⁵ The authors reported an initially similar clinical time spent for both prostheses, suggesting that OVDs represent a more economical alternative. However, when evaluating the long-term maintenance, they stated that IOVDs have a higher incidence of remakes, relines, and general adjustments, and more appointments were necessary from the first year and beyond.⁵⁵

In a similar study, where direct clinical and time costs were assessed over a period of 9 years, the mean clinical and time costs were significantly greater for the fixed restoration group in comparison to the IOVD group.⁵⁶ Following the same pattern, initial and maintenance costs were significantly higher in the fixed prosthesis group (2,527 vs 830 Canadian dollars, respectively; $P = .01$), mainly due to the fact that patients in the fixed implant group required a higher number of implants.

On the contrary, in another study, the two different prosthesis types were compared in 17 patients who all received three standard Brånemark implants and were randomly assigned to either the fixed or the removable group.⁵⁷ The authors concluded that a fixed implant-supported prosthesis in the edentulous mandible could be provided at about the same cost as an overdenture using a three-implant support concept.

DISCUSSION


Number of Implants

The number of implants for mandibular IFCDs has ranged from two to eight,¹¹ and for mandibular IOVDs from one to four or more. There is not adequate evidence to support IFCDs with three or fewer implants, and therefore, more long-term studies are needed.¹¹ The disadvantage of having a fixed prosthesis with two or three implants is that if one implant is lost after delivery of the prosthesis, then new implant(s) as well as a new prosthesis will be required, causing patient inconvenience, dissatisfaction, and increased clinic time for the dentist. On the other hand, if one implant is lost in a prosthesis with five or more implants, there is always the option to maintain the prosthesis without replacing the lost implant (unless it is the most distal one). Increasing the number of implants will increase the laboratory and clinical costs and become a more technique-sensitive and challenging-to-restore approach for the clinician. A low number of implants could be essential in cases of anatomical limitations, cases where treatment time should be expedited, and in cases where major augmentations are not feasible. Additionally, prostheses with a low number of implants have lower costs than prostheses with a greater number of implants. Last but not least, in certain cases, an increased number of implants can complicate the oral hygiene of the patients due to limited accessibility in all surfaces.

For mandibular IOVDs, the most commonly reported number of implants is two. Implants are generally placed interforaminally and can be either sole abutments (with stud attachments, etc) or splinted with a bar. Even though there is recent evidence that one implant overdenture has high survival rates,²¹ two implants should be the number of choice for mandibular IOVDs. A single-implant OVD may be used under certain conditions, such as inadequate bone for another implant or anatomical/financial limitations.⁵⁸

Short-Length and Narrow-Diameter Implants

As stated earlier, several studies have reported high survival rates with short implants. However, there is controversy surrounding how to define a "short" implant. There are studies considering short implants as being < 10 mm length, and others that consider short implants as ≤ 8 mm.^{16,17} Short implants have several advantages, such as reduced need for bone augmentation, avoidance of major anatomical structures (eg, inferior alveolar nerve, lingual concavity), decreased treatment time, increased clinician efficiency, and reduced treatment cost. This is the reason why most implant companies have a short implant with aggressive threads available in their armamentarium that can be used successfully in the aforementioned clinical situations.



Regarding narrow-diameter implants, and according to the 6th ITI Consensus Report, there are three categories: < 3-mm diameter; 3.0- to 3.25-mm diameter; and 3.3- to 3.5-mm diameter.²⁹ There are still clinicians who use mini-implants to support definitive full-arch prostheses; however, narrow-diameter implants have not been adequately investigated, and so more studies are needed in order to assess their long-term biomechanical behavior.²⁹

Loading Protocols

All three loading protocols have been clinically and scientifically documented for mandibular IFCDs. For mandibular IOVDs, clinicians tend to be more conservative and prefer either early or conventional loading.³³ These two loading protocols have been studied more for mandibular IOVDs. Immediate loading has several advantages, such as decreased treatment time, increased clinician efficiency, and increased patient satisfaction and confidence, as well as reduction of postoperative patient discomfort from a potential provisional removable complete denture.⁵⁹

Prosthetic and Implant Survival Rates

Several studies have reported high prosthetic and implant survival rates for both IFCDs and IOVDs.^{37,38,40–42} Survival is important, but another crucial factor is success. Not many studies have assessed the success of these prostheses. Patient satisfaction, as well as the number of complications, affect the success of the treatment and should always be taken into consideration. Furthermore, future studies should focus more on evaluating and reporting PROMs and prosthesis success rates in order to provide stronger and more valuable scientific outcomes.

Mechanical and Biologic Complications

Even though several studies have reported on complications, there is a very limited number of studies reporting outcomes for more than 5 years.⁴⁵ Mechanical and biologic complications have been categorized into minor and major.³⁸ Minor mechanical complications are the ones that can be repaired chairside (such as wear of IOVD patrices, screw wear, minor chipping/fracture of veneering material, and others), while major mechanical complications require further intervention (eg, major chipping/fracture of veneering material, framework fracture, etc). The literature reports a higher number of minor complications, and as a result of this increase, it is logical to expect increased chair time and maintenance cost and a decrease in patient satisfaction.³⁸

In order to reduce the total number of complications, several approaches can be followed. In the last few years, new materials, such as zirconium, have been successfully used for IFCDs, and many reports have observed high survival rates with these zirconia prostheses.^{60,61}

An additional approach would be to make sure patients have regular follow-up and maintenance appointments, as minor complications can be identified during these appointments at an early stage before proceeding to the next step, preventing the development of further, more advanced complications.

Minor and major biologic complications have also been described.³⁸ Minor biologic complications can be reversible (eg, soft tissue inflammation, peri-implant mucositis, soft tissue overgrowth), while major complications cannot always be reversed (eg, peri-implantitis). From a prosthetic standpoint, factors such as the design of the intaglio surface, the type of material (resin vs ceramic vs zirconium), and prosthesis dimensions (mainly width) should be taken into account in order to decrease the development of biologic complications. Common examples are metal-ceramic IFCDs, which are less “bulky” than metal-resin ones and allow for easier access and improved oral hygiene for all patients, but especially for older individuals or people with dexterity problems. Another important factor is patient compliance during and after the completion of treatment. Patients should be informed that prosthesis maintenance is essential for the longevity of the treatment. At the same time, clinicians should have a strict and individualized maintenance and recall protocol for their patients.⁵

Patient-Reported Outcome Measures

Patients tend to be more satisfied with IFCDs compared to IOVDs when it comes to chewing ability and overall stability. In cases of IOVDs, oral hygiene is always easier to perform, since the prosthesis can be removed and cleaned. As mentioned previously, a limited number of studies report on PROMs, and one of the main limitations is related to the fact that these measures have not been standardized in implant dentistry. It is essential for future studies to focus more on patient-centered outcomes, including function, esthetics, and patient satisfaction, which are crucial factors for determining the success of these prostheses.

Financial Implications

Due to a lack of systematic reviews on the financial implications of these treatment methods, no conclusions or recommendations could be made. In general, fixed restorations have increased laboratory and clinical costs compared to removable restorations. However, when considering the overall treatment cost, the laboratory cost, clinical time, and cost of future maintenance should also be considered. This means that prostheses that require increased maintenance, such as metal-resin IFCDs, might be less cost-effective after 5 years than metal-ceramic prostheses, which have a higher initial cost but significantly lower annual complication rates.

When evaluating the research on the financial implications of the aforementioned prostheses, it remains critical to take into consideration not only the number of implants used, but the prosthetic material as well as the geographic location where the dental work took place. A metal-resin fixed prosthesis has a completely different financial cost, both for the clinician and the patient, compared to a metal-ceramic one.

CONCLUSIONS

Both implant-supported overdentures and implant-supported fixed complete dentures represent scientifically valid and clinically successful treatment approaches. Every clinician should carefully treatment plan each case after a thorough evaluation of the clinical and radiographic findings, the specific anatomical limitations, and the patient's demands. In cases where both options are possible, patient expectations and cost should be the determining factors that finalize which treatment modality will be followed.

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