



Implant and root supported overdentures - a literature review and some data on bone loss in edentulous jaws

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PURPOSE. To present a literature review on implant overdentures after a brief survey of bone loss after extraction of all teeth. **MATERIALS AND METHODS.** Papers on alveolar bone loss and implant overdentures have been studied for a narrative review. **RESULTS.** Bone loss of the alveolar process after tooth extraction occurs with great individual variation, impossible to predict at the time of extraction. The simplest way to prevent bone loss is to avoid extraction of all teeth. To keep a few teeth and use them or their roots for a tooth or root-supported overdenture substantially reduces bone loss. Jaws with implant-supported prostheses show less bone loss than jaws with conventional dentures. Mandibular 2-implant overdentures provide patients with better outcomes than do conventional dentures, regarding satisfaction, chewing ability and oral-health-related quality of life. There is no strong evidence for the superiority of one overdenture retention-system over the others regarding patient satisfaction, survival, peri-implant bone loss and relevant clinical factors. Mandibular single midline implant overdentures have shown promising results but long-term results are not yet available. For a maxillary overdenture 4 to 6 implants splinted with a bar provide high survival both for implants and overdenture. **CONCLUSION.** In edentulous mandibles, 2-implant overdentures provide excellent long-term success and survival, including patient satisfaction and improved oral functions. To further reduce the costs a single midline implant overdenture can be a promising option. In the maxilla, overdentures supported on 4 to 6 implants splinted with a bar have demonstrated good functional results. [*J Adv Prosthodont 2014;6:245-52*]

KEY WORDS: Ball attachment; Early loading; Mandibular 2-implant overdenture; Maxillary implant overdenture; Single midline implant

INTRODUCTION

Old age was for long considered inevitably accompanied by the loss of teeth. The prevalence of edentulism is also

strongly associated with ageing although it is now well known that teeth can be kept all the life in many individuals. The rate of edentulousness differs much between countries and it has declined dramatically during the last few decades in most countries.^{1,2} A nationwide study in Sweden over two decades showed that the prevalence of edentulism in subjects aged 55-84 years was 43 % in 1980-81 and 14% in 2002. In the youngest age group (55-64 years) only 4% were edentulous in 2002.³ In a more recent study the prevalence of edentulism in 2012 among 70-year-old subjects in Sweden was only 3 %.⁴ It is now well established that the loss of teeth is related to a number of factors, such as socio-economy, tradition, oral health resources, and not only to dental diseases.^{1,5}

Until the introduction of osseointegrated implant-supported prostheses, complete dentures were the only available treatment for edentulous patients. A recent review concluded that in most societies, the need for complete

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dentures is not likely to reduce in the near future in spite of the dramatically improved therapeutic possibilities provided by osseointegrated dental implants. The edentulous people in the world belong to the poorest section of the population and implant treatment is unrealistic for them; for many even “low-tech” therapies like conventional dentures are beyond their reach.⁶

Brånemark and co-workers presented a fixed prosthesis on 5-6 implants as a viable treatment for edentulous jaws, and during many years this was the dominating concept with extremely successful long-term results.⁷⁻⁹ However, in the mid 1980's treatments with mandibular implant overdentures were introduced.¹⁰ Being less expensive and less complicated but yet successful, mandibular implant overdentures soon became popular in many countries.^{11,12} Maxillary implant overdentures on few implants have in general been found less successful than the mandibular 2-implant overdenture.^{13,14}

It is the aim of this article to present a literature review on implant overdentures after a survey of bone loss after tooth extraction and prosthodontic treatment.

LITERATURE

The literature on dental implants is increasing rapidly. In 2003 PubMed listed 6,800 titles, in 2014 the number had increased almost four times to 24,600. The number of publications on implant overdentures has also increased during these 11 years, from 780 to 1,800. It was not the purpose to make a systematic review of this literature, only to give a narrative review of some trends related to implant and root-supported overdentures reflected in selected publications, but starting with some aspects on the consequences of extraction of teeth.

REDUCTION OF RESIDUAL RIDGES

After tooth extraction the alveolar process is reduced due to bone loss, with great individual variation, which is impossible to predict at the time of extraction (Fig. 1).¹⁵ For many patients this can lead to severe problems for the retention of conventional dentures. A classical paper even characterized this reduction of the residual ridges as “a major oral disease entity”.¹⁶ Is this relevant also in 2014? With respect to the fact that the majority of edentulous subjects will have to continue relying on complete dentures,⁶ the phenomenon of bone loss needs continuing consideration. The term bone resorption is not always adequate and it has been suggested that bone loss should be used instead.¹⁷

Even if the rate of edentulism is decreasing in most countries, a study in USA prognosticated that there would be an increase of the number of edentulous jaws to 38 million in 2020, mainly due to demographic reasons: people live longer and the number of elderly increases. In that paper, implants were not mentioned as an option for the edentulous subjects, only complete dentures.¹⁸ This can be interpreted as a consequence of the socio-economic situation of the edentulous people; this segment of the population is poor and not able to ask for implant treatment. As this is the situation in the richest country in the world, it is even worse in a global perspective.^{6,19}

Numerous factors have been proposed to be of possible importance for bone loss in residual ridges (Table 1). No dominant factor has been identified. However, it is suggested that combinations of anatomic, metabolic, psychosocial, mechanical and yet unknown factors may be responsible but the mechanisms are not well understood.^{17,20}

There are some possible ways to prevent or at any rate

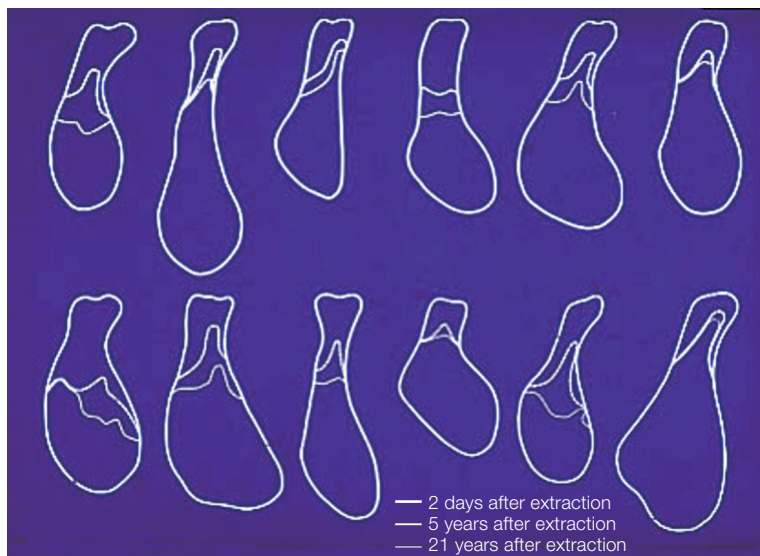


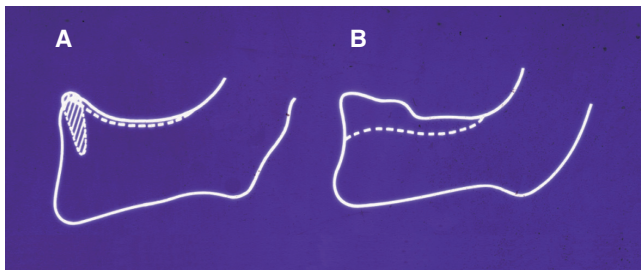
Fig. 1. Tracings from profile radiographs of mandibular symphyseal region of 12 subjects 2 days, 5 years and 21 years after extraction of all teeth in the mandible (with permission from J Prosthet Dent¹⁵).

Table 1. Factors of possible importance for bone loss in residual ridges

· Age	· Duration of edentulism
· Gender	· Number of dentures worn
· Facial morphology	· Denture wearing habits
· Nutrition	· Oral parafunctions
· General health	· Occlusal loading
· Medication	· Denture quality
· Osteoporosis	· Oral hygiene
· Systemic disease	

Table 2. Ways to prevent or reduce bone loss of residual ridges

· Prevention - do not extract all teeth
· Preserve a few teeth - overdentures
· Place implants for implant-supported prostheses
· Optimize patient nutrition and health
· Optimize dentures
· Ask patients not to use dentures always

**Fig. 2.** Comparison of bone loss in a patient with a root-supported overdenture (A) and a conventional complete denture (B) 5 years after extraction of teeth and insertion of dentures (with permission from J Prosthet Dent²¹).

reduce the bone loss of residual ridges (Table 2). The simplest is of course to avoid extraction of all teeth. To keep a few teeth and use them or their roots for a tooth or root-supported overdenture has been shown to substantially reduce the bone loss in the mandible (Fig. 2).²¹ A classical textbook on root-supported overdentures describes a number of solutions which should be considered before the decision is made to extract all remaining teeth.²² There are many advantages of root or tooth supported overdentures compared to complete dentures such as improved denture stability and retention. There are relatively few studies on the survival of tooth and root supported overdentures but those available have demonstrated a wide range of survival rates, from very good to relatively poor results, and a great need for prosthetic maintenance.²³ Nevertheless tooth or root supported overdentures are a therapeutic option that deserves more attention because of its obvious advantages compared to conventional complete dentures.

Dental implants and bone loss in residual ridges

Jaws with implant-supported prostheses show less bone loss than jaws with conventional dentures, probably because of more adequate functional stimulus to the bone via implants than through dentures.^{11,24-26} Not only reduced bone loss but even bone apposition has been demonstrated

in jaws with fixed implant-supported prostheses.^{26,27} This bone preserving effect of implant-supported prostheses should be included in the decision making for the edentulous mandible.

MANDIBULAR IMPLANT OVERDENTURES

Several randomized control trials have demonstrated that implant overdentures provide patients with better outcomes than do conventional dentures, e.g. regarding satisfaction, chewing ability and oral-health-related quality of life. A mandibular implant overdenture on two implants is thus a well-established and effective option, also in a long-term perspective.^{11,28} It has even been suggested that it should become the first choice of treatment for the edentulous mandible.^{29,30} This is a tempting possibility but it has been criticized as unrealistic, mainly because of the fact that the edentulous patients are poor and cannot afford any implant treatment.^{6,19} It should also be remembered that the majority of complete denture wearers are quite satisfied with their predicament, both functionally and esthetically.^{4,31} More than a third of edentulous patients choose to stay with conventional dentures even when offered a mandibular implant overdenture free of charge.³²

Retention system for implant overdentures

The retention systems for the 2-implant overdenture can be divided into splinted and unsplinted ones. The splinted systems use an interconnecting bar and a retentive clip; for the unsplinted implants there are several retention types available such as ball attachments and magnets. There is no strong evidence for the superiority of one system over the others regarding patient satisfaction, survival, peri-implant bone loss and relevant clinical factors. Common to all systems is that they require substantial prosthodontic maintenance with time and cost implications, which should be included in the economic aspects of the treatment.³³ However, irrespective of the differences between the retention systems, mandibular implant overdentures provide increased patient comfort and acceptance as well as oral function compared to complete dentures.¹¹

Early loading

Early loading of mandibular implant overdentures at 6 weeks or even 2 weeks has been shown to be an effective treatment. Loading can be minimized by requesting the patients to eat only soft meals for the first few weeks¹¹ Based on recent studies it has been concluded that early loading protocols produce equal outcomes as conventional loading and thus is a viable option in construction of mandibular overdentures.^{34,35} However, a recent systematic review concluded that although all three loading protocols (immediate, early and conventional loading) provide high survival rates, early and conventional loading protocols are still better documented than immediate loading and seem to result in fewer implant failures during the first year.³⁶

Cost of treatment of edentulous jaws

When comparing the cost of different treatment options it is clear that the cheapest alternative is the conventional complete denture followed by the implant overdenture; a fixed implant-supported prosthesis is the most expensive. Economical aspects on prosthodontic treatment are rare but a few studies deserve to be mentioned. Long-term comparisons (over 9 and 15 years) have demonstrated that overdentures are a more cost-effective treatment compared to fixed prostheses.³⁷ In a comparison of different types of overdentures it was shown that a construction using 4-implants was more expensive than one with 2 implants but required less aftercare over 8 years. Nevertheless, the authors concluded that the 2-implant bar-retained overdenture was most effective when considering other factors such as patient satisfaction, clinical implant performance and cost-effectiveness.³⁸ Another study found that there was no difference in cost between 2- and 4-implant overdentures over 10 years. The 2-implant overdenture was therefore more cost-effective.³⁹

It seems to be almost consensus in the literature today that in the mandible two implants are sufficient for the

retention/support of an overdenture; this option is accompanied by excellent results also in the long run.^{28,30}

SINGLE MIDLINE IMPLANT

To reduce the cost of treatment a single midline implant has been tried to retain a mandibular implant overdenture (Fig. 3). An early 5-year study demonstrated good results with such an overdenture.⁴⁰ These and similar results⁴¹ led to a suggestion to use the single midline implant overdenture as an inexpensive treatment for geriatric and other patients with low functional demands. During the last few years several short-term randomized clinical trials have been presented indicating an increased interest in the profession to evaluate this option.⁴²⁻⁴⁵ The results of these short-term studies have in general been assessed as promising but long-term observations are required for a firm conclusion regarding the clinical usefulness of mandibular overdentures supported by a single midline implant.

MAXILLARY IMPLANT OVERDENTURE

Implant overdentures in the maxilla have in general not been as successful as in the mandible, but the early poor results were probably partly due to the fact that maxillary implant overdentures often were made as a “rescue treatment” when a fixed prosthesis had failed. The results improved when maxillary implant overdentures were made as a planned treatment following strict protocols.¹³ Nevertheless it is evident that maxillary implant overdentures present a number of different challenges compared to the predictable benefits of mandibular 2-implant overdentures.^{46,47} Systematic reviews concluded that maxillary overdentures on 4 or more implants in a splinted construction provided high survival (> 95% for the first year) both for implants and overdenture.^{14,48} Long-term results regarding maxillary implant overdentures are still rare and when avail-

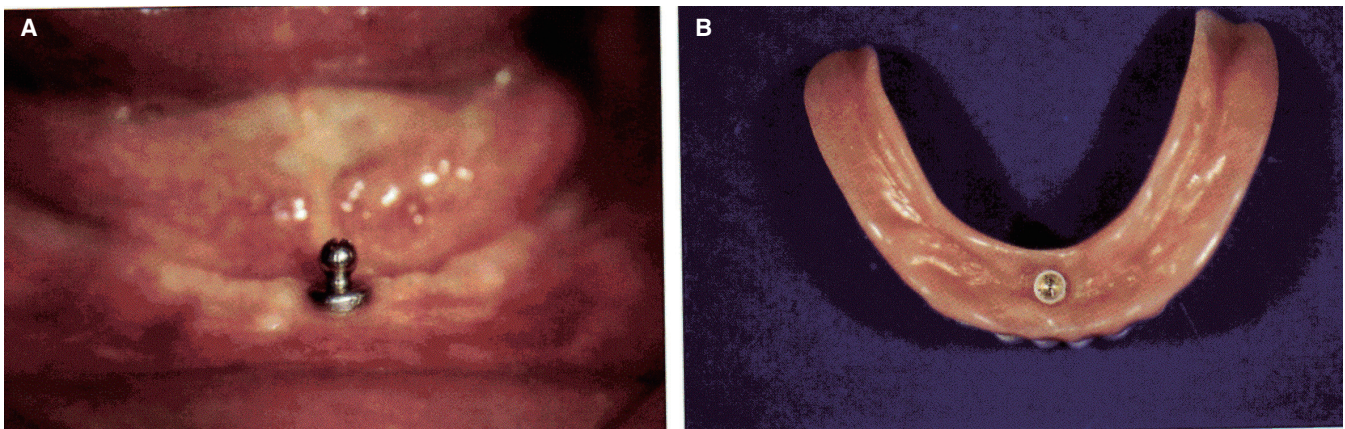


Fig. 3. (A) Single implant with a ball attachment in an edentulous mandible to retain an overdenture. (B) The inner surface of the mandibular overdenture with retainer for the ball attachment (with permission from Int J Oral Maxillofac Implants⁴¹).

able often inconsistent.⁴⁹ However, following the recommendation to use 4 or more implants splinted with a bar system a maxillary overdenture can be a successful treatment option (Fig. 4). Using four or less implants and a ball attachment system is in general less successful.

IMPLANT OVERDENTURE OR FIXED IMPLANT-SUPPORTED PROSTHESIS

Many factors influence the choice between a fixed and removable implant prosthesis in treatment of an edentulous patient. At the introduction of osseointegrated implants in Sweden in the 1970s, professor Brånemark⁷ suggested fixed prostheses as the first choice. This was also for long the policy among prosthodontists in Sweden. The great majority of implant treatments of edentulous mandibles consisted of fixed prosthesis, only a small part was implant overden-

tures according to a questionnaire study regarding year 2001.⁵⁰ In this respect not much has changed during the last decade among prosthodontists in Sweden: in 2012 the ratio between fixed implant-supported prostheses overdentures in edentulous mandibles was 17 to 3, similar to the results 10 years earlier.⁵¹ The same type of questions presented to prosthodontists in 10 countries demonstrated a great variation of the use of implant overdentures in year 2001.¹² In fact, the proportion of implant overdentures to fixed implant-supported prostheses regarding implant treatments of the edentulous mandible varied from 12% in Sweden to 93% in the Netherlands. In Korea the proportion was approximately 50/50% (Fig. 5). There is no current data published but it would be interesting to see the recent development internationally concerning the choice between overdenture or fixed prosthesis in implant treatment of the edentulous mandible.

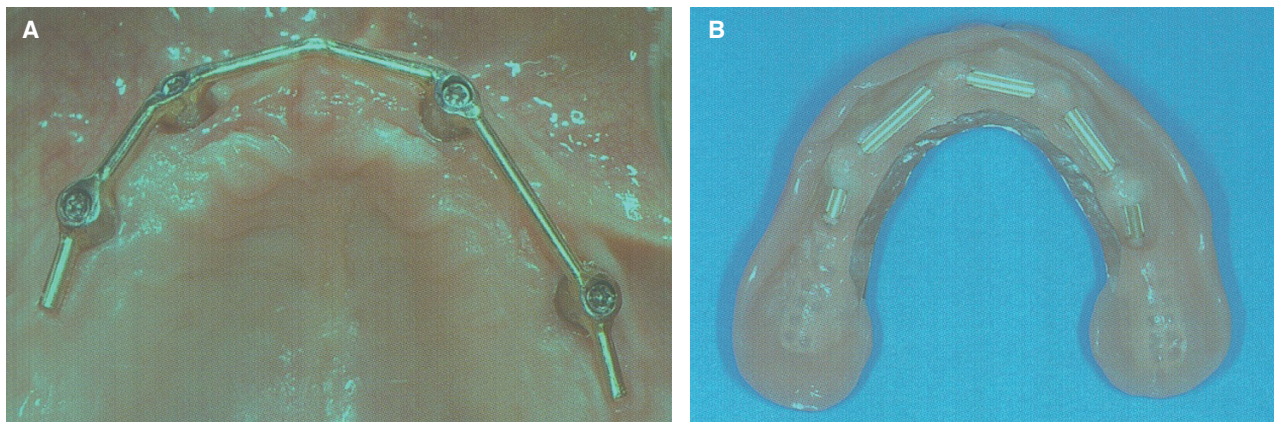


Fig. 4. (A) Four implants in an edentulous maxilla splinted with a bar for an overdenture. (B) The inner surface of the maxillary overdenture showing the bar retainers fixed in the denture base material (with permission from Quintessence¹³).

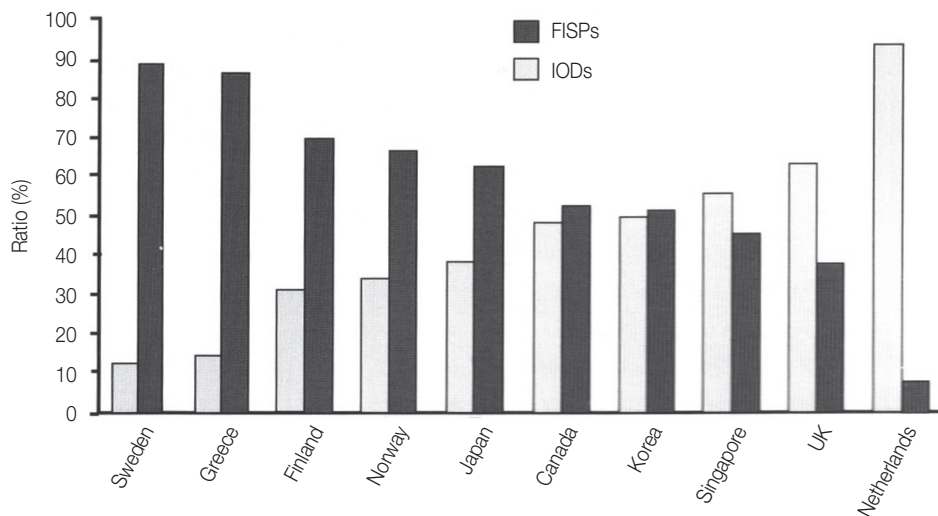


Fig. 5. Distribution of the use of implant overdentures (IODs) and fixed implant-supported prostheses (FISPs) for implant treatment of edentulous mandibles in 10 countries (with permission from Int J Prosthodont¹²).

DISCUSSION

The international interest in dental implants has developed almost exponentially during the last three decades, starting after the Toronto conference in 1982 when Professor Brånemark and his group from the University of Gothenburg presented their, by that time incredibly successful, results of treatment with osseointegrated implants.⁵² The originally predominant prescription of fixed implant prostheses has gradually been supplemented with other options, among which implant overdentures is the focus of this article. There is overwhelming evidence that implant overdentures are superior to conventional complete dentures in several aspects, especially for the edentulous mandible. It has therefore been suggested that, if possible, mandibular implant overdentures should be the first option for complete denture wearers with adaptation difficulties.^{29,30}

Even if the prevalence of edentulism is decreasing in most countries there is still a great number of edentulous individuals needing treatment. A majority of them belong to the poorest segment of the population and cannot afford implant treatment; they will have to rely on complete dentures.^{6,19}

For complete denture wearers with adaptation difficulties the mandibular denture is usually the most critical problem. Treating such patients with a fixed implant-supported prosthesis in the mandible but keeping the maxillary complete denture led to dramatic improvement of oral functions and “oral well-being” both in short- and long-term perspectives.^{9,53} The great functional improvement provided by a mandibular implant overdenture together with a maxillary complete denture is well established.^{11,28,30} A mandibular 2-implant overdenture is less expensive than a fixed implant-supported prosthesis and can therefore make implant treatment available to more edentulous patients. Another way to further reduce the cost of implant treatment and expand the benefits of it to more people is by using a single midline implant as support for a mandibular overdenture. This is a promising option according to short-term studies but awaiting long-term evaluation.^{42,45}

The stable and successful long-term results for 2-implant overdentures in the mandible cannot be transferred to the maxilla. A maxillary implant overdenture needs more support, preferably 4 to 6 implants splinted with a bar, to reach similar results as a 2-implant option in the mandible.

CONCLUSION

The bone loss of the alveolar process after tooth extraction occurs with great individual variation, impossible to predict at the time of extraction. The simplest way to prevent the bone loss is to avoid extraction of all teeth. To keep a few teeth for a tooth or root-supported overdenture has been shown to substantially reduce the bone loss.

In edentulous mandibles 2-implant overdentures provide excellent long-term success and survival, including patient satisfaction, improved oral functions and oral health

related quality of life. To further reduce the costs a single midline implant overdenture can be a promising option. In the maxilla overdentures need to be supported on more than 2 implants; 4 to 6 implants splinted with a bar have demonstrated good functional results.

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