

A Survey of the Use of Mandibular Implant Overdentures in 10 Countries

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Purpose: This preliminary international survey compared provision of implant-retained overdentures to fixed implant-supported prostheses for edentulous mandibles. **Materials and Methods:** Questionnaires based on a 2001 Swedish study were sent to prosthodontists and specialist clinics in nine additional countries. **Results:** Response rate varied from 53% to 100% in 10 national surveys and should allow careful comparison of results. The relationship between implant overdentures and fixed implant-supported prostheses in treatment of edentulous mandibles varied much; in Sweden, the proportion of overdentures was 12%, whereas it was 93% in the Netherlands. In all countries, the most common reason for choice of the overdenture was reduced cost. In all but two countries, the majority of respondents thought that patients with implant overdentures were equally or more satisfied with overdentures as those with fixed implant-supported prostheses. **Conclusion:** There were great differences among the 10 countries in choice of implant treatment of the edentulous mandible. The relative proportion of mandibular overdentures to fixed prostheses was low in Sweden and Greece and varied from one to two thirds in the other countries, except the Netherlands. *Int J Prosthodont* 2004;17:211–217.

The long-term success of osseointegrated implants in the management of edentulism is well-established.^{1–3} A recent prospective study presented excellent results over more than 20 years for fixed implant-

supported mandibular prostheses.⁴ However, restrictions in economy and resources have precluded many edentulous patients from receiving the challenging and expensive fixed restorations, and implant overdentures seem to have become an attractive and relatively inexpensive treatment alternative in several centers.^{5–11} A 1998 review of management of the maladaptive edentulous patient concluded that there is a need for less invasive, less expensive, less complex, and equally effective treatment options, such as the implant-supported overdenture.¹² Based on surveys of current literature, a 2002 symposium presented a consensus statement concluding that there is now overwhelming evidence that a two-implant overdenture should be the first choice of

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Table 1 Clinics in Each Country, Response Rate, No. of Implant Overdentures (IODs) and Fixed Implant-Supported Protheses (FISPs), and Mean % of Implant Patients with Edentulous Mandibles

| Country | No. of responding clinics | Response rate (%) | No. of IODs (Q1) | No. of FISPs (Q2) | % of implant patients with edentulous mandibles (Q3) |
|----------------|---------------------------|-------------------|------------------|-------------------|--|
| Canada | 1 | 100 | 60 | 65 | 30 |
| Finland | 36 | 60 | 197 | 439 | 39 |
| Greece | 34 | 85 | 148 | 943 | 26 |
| Japan | 17 | 100 | 25 | 41 | 7 |
| Korea | 5 | 83 | 21 | 22 | 17 |
| Netherlands | 27 | 63 | 3,778 | 276 | 81 |
| Norway | 16 | 67 | 42 | 80 | 19 |
| Singapore | 16 | 59 | 18 | 15 | 17 |
| Sweden | 28 | 93 | 87 | 647 | 18 |
| United Kingdom | 233 | 53 | 778 | 448 | 25 |

Q1 to Q3 = question No. from the questionnaire.

treatment for the edentulous mandible.¹³ However, a recent survey in Sweden demonstrated that the use of implant-retained overdentures is rare in comparison with fixed implant-supported protheses in treatment of edentulous mandibles.¹⁴

It would therefore be of interest to examine the proportion of different implant protheses used today in other countries. The purpose of this international survey was to study the distribution of removable and fixed protheses for treatment of edentulous mandibles, the number of implants placed, and the type of retention systems used for implant-retained mandibular overdentures. The hypothesis was that the use of mandibular implant overdentures differs between countries, but that there is an increasing demand for this treatment alternative.

Materials and Methods

In January 2002, questionnaires related to opinions on and use of mandibular implant overdentures were sent to the heads of the 30 prosthodontic specialist clinics of the Public Dental Health Service in Sweden. The questions regarding treatment referred to 2001. Completed questionnaires were received from 28 (93%) of the 30 clinics, and the results have been published.¹⁴ Based on this study, similar surveys were performed in nine other countries: Canada, Finland, Greece, Japan, Korea, the Netherlands, Norway, Singapore, and United Kingdom.

The same questionnaire (comprising eight questions after exclusion of one question regarding a specific Swedish situation) was used after translation to the appropriate language. The following questions were included in the questionnaire (response options within parentheses):

1. How many treatments with mandibular implant overdentures were performed in your clinic during 2001? (In the UK, year 2002 was asked for.)

2. How many patients received fixed implant-supported mandibular protheses in your clinic during 2001? (In the UK, year 2002 was asked for.)
3. How many of all implant-treated patients at the clinic comprised those with an edentulous mandible? (Respond in %.)
4. How were the retention/attachment systems distributed among the implant overdentures? (a = two implants with bar and clips; b = two separate implants + attachment—if so, which attachment?; c = other system—if so, which?)
5. What was the main reason(s) for choosing an overdenture instead of a fixed prosthesis? (Mark one or more alternative: a = costs; b = amount of bone; c = jaw relation; d = patient was only interested in better denture retention; e = other reason—describe.)
6. Has the demand for overdentures increased in relation to fixed implant protheses during the last few years? (a = yes; b = no; c = do not know.)
7. Do you think that, in comparison to patients with fixed implant protheses, patients with mandibular implant overdentures are (a = less satisfied; b = equally satisfied; c = more satisfied)?
8. If you have other views on the questions above, please give your comments in the space provided below.

Because of the different dental health systems in the 10 countries, the selection of the clinics to receive the questionnaires varied and could not be consistent in all national surveys. Based on the situation in each country, the country representative sent questionnaires to clinicians, clinics, and centers/hospitals with active implant programs. The number of selected units and response rate varied substantially (Table 1). Following are some details of the methods used in the countries.

In Canada, the university clinic for postgraduate prosthodontics in Toronto was included. It is a "service"

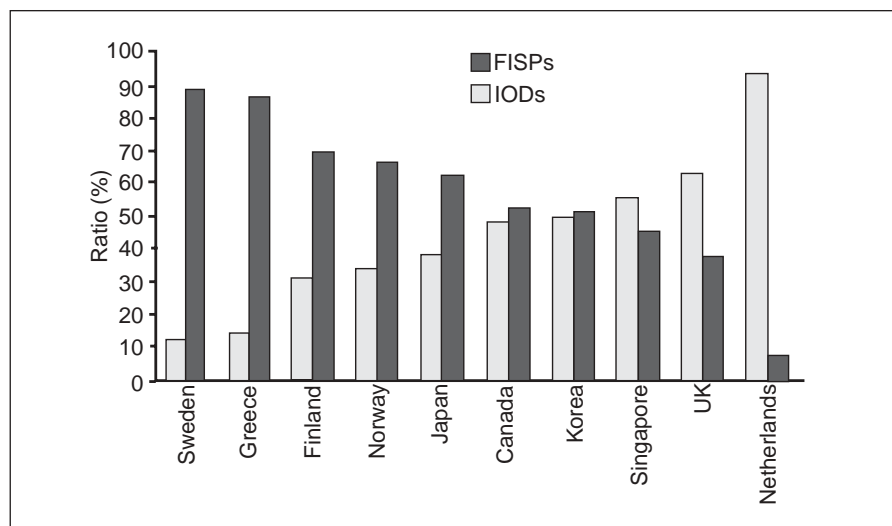


Fig 1 Ratio of implant overdentures and fixed implant-supported prostheses provided to patients with edentulous mandibles in 10 countries in 2001. The countries are arranged according to increasing ratios of implant overdentures. *FISP* = fixed implant-supported prosthesis; *IOD* = implant overdenture.

clinic, the only university clinic that is open to the public.

In Finland, all members of the Finnish Society of Oral Implantology received the questionnaire, but only 60 were actively involved in implant treatment; of these, 36 (60%) sent in their answers.

In Greece, the questionnaire was sent to 40 dental clinics or dental offices known to offer prosthodontic treatment to implant patients, including the two university clinics (National & Kapodistrian University of Athens, Faculty of Dentistry, and Aristotle University, Thessaloniki). The response rate was 85%.

In Japan, the study was limited to Kyushu, an island in the south of the country with 12,000,000 inhabitants. The questionnaires were sent to established implant clinics and all university hospitals on the island. The response rate was 100%. One of the clinics did not use implants in edentulous patients.

In Korea, three university clinics and three hospital clinics well-known for significant implant activities received questionnaires. Answers were received from five of the six clinics (response rate 83%).

In the Netherlands, questionnaires were sent to 43 clinics and hospitals well-known for significant implant activity. Twenty-seven clinics sent back completed questionnaires, giving a response rate of 63%.

In Norway, questionnaires were sent to 24 of the 42 prosthodontic specialists listed in the register maintained by the Norwegian Association for Oral Prosthetics. These clinicians were recognized to be actively involved in implant-based prosthodontics. The response rate was 67%.

In Singapore, questionnaires were sent to 27 prosthodontically trained clinicians (Singapore does not have a dental specialist register as yet), and 16 replied. Only nine of them undertook implant treatment on edentulous patients.

In the UK, the questionnaire was sent to all 443 clinicians who were on the specialty list for prosthodontics and/or restorative dentistry. Replies were received from 233, of whom 120 undertook implant work (of these, 58% worked only in the private sector, 23% worked in a hospital or similar environment where treatment would normally be provided free of charge, and the remainder worked part time in both). How many of the original group worked with implants is not known.

Results

The reported number of treatments with mandibular implant overdentures varied much among the countries, with the highest values in the Netherlands (Table 1). The proportion of overdentures among the implant treatments provided for edentulous mandibles varied from 12% in Sweden to 93% in the Netherlands (Fig 1). Great variation among the countries was also evident regarding percentage of implant patients with edentulous mandibles (7% in Japan to 81% in the Netherlands).

The most common reason to choose an implant overdenture instead of a fixed prosthesis was the reduced cost. Other factors often added to the reduced cost were patient-related factors such as amount of jawbone, jaw relation, need for soft tissue support, and patient's main interest in better denture retention.

Table 2 Responses to Questions (Q) 4 to 7 from the Questionnaire: % of Responding Clinics

| Country | Q5a: Cost main reason for IOD* | Q4a: Two implants bar + clips† | Q4b: Two separate implants | Q4c: Other systems | Q6a: Increased demand for IOD‡ | Q7b+c: Equally or more satisfied with IOD |
|----------------|--------------------------------|--------------------------------|----------------------------|--------------------|--------------------------------|---|
| Canada | 100 | 100 | — | — | 100? | 100 |
| Finland | 56 | 42 | 23 | 35 | 19 | 70 |
| Greece | 91 | 70 | 52 | 33 | 9 | 42 |
| Japan | 59 | 67 | — | 73 | 35 | 71 |
| Korea | 100 | 100 | 60 | — | 20 | 20 |
| Netherlands | 81 | 92 | 11 | 81 | 24 | 68 |
| Norway | 83 | 33 | 83 | 17 | 7 | 64 |
| Singapore | 89 | 28 | 72 | — | 33 | 78 |
| Sweden | 71 | 29 | 64 | 11 | 18 | 67 |
| United Kingdom | 78 | 64 | 78 | 35 | 23 | 64 |

*Other reasons may also have been mentioned.

†Several clinics use more than one system.

‡% of responding clinics, including the few that answered "do not know."
IOD = implant overdenture.

Two implants was the usual number to retain the mandibular overdenture, although a few clinics preferred three or four implants. The type of anchorage system varied much, but the most commonly used was two implants with a bar and clips and two implants with ball attachments (Table 2).

The most common answer in 8 of the 10 national surveys to question 6, whether the demand for implant overdentures had increased during the last few years in relation to fixed prostheses, was "no." The median frequency of those who thought that the demand had increased was 19%. A great majority of the respondents in 8 of the 10 countries thought that patients with implant overdentures were equally or more satisfied than those with fixed implant-supported prostheses.

Discussion

The main finding of this study was the great variation among and within the 10 countries in the ratio of implant overdentures to total implant treatment of edentulous mandibles. The reasons for this variation may differ among the countries, but prosthodontic traditions and economic factors are probably most important. In Sweden, there has been a strong preference for fixed prostheses in conventional as well as implant prosthodontic treatment during the last few decades. The originally very generous Swedish dental insurance system introduced in 1974 made fixed restorations available to most patients, and the cost difference between fixed and removable prostheses became small for patients. The original work by the Brånemark group described only fixed implant-supported prostheses.^{1,15} These conditions may largely explain the predominance of fixed implant prostheses in Sweden.¹⁴

The similarly high prevalence of fixed implant-supported prostheses in Greece may have a partly different explanation. The Greek national health care

system does not reimburse expenses related to surgical implant placement. This fact has two consequences: (1) Private patients who pay themselves often ask for fixed rather than removable types of implant restorations; and (2) since the restorations can be reimbursed, and the price for a fixed restoration is higher than for a removable prosthesis, patients prefer the fixed solutions with a higher reimbursement from the national health care system. There is anecdotal evidence that both patients and clinicians in Greece prefer a fixed implant-retained restoration compared to a removable one. Clinicians who work with implant prosthodontics are said to be more comfortable with fixed restorations because of the reported lower maintenance requirements compared with removable restorations.¹⁶ It is probable that the clinician's opinion is reflected in the recommendation to the patient and may play an important role in the patient's final decision.

Economic factors obviously are also important in other countries. Although 58% of the clinicians in the UK worked only in the private sector, they treated 34% of the overdenture cases; those who worked only in the National Health Service, and who made up 23% of the respondents, accounted for 46% of the treatments. This would suggest that where funds are limited, as in the National Health Service, overdenture treatment is viewed as an attractive and cost-effective way of treating the edentulous situation.

The very strong predominance of overdentures in the Netherlands may be explained by the fact that the Dutch National Health Service, as well as most private insurance companies, reimburses most costs of implant overdentures in edentulous people with atrophy of the residual alveolar ridge, whereas there is no reimbursement for fixed restorations. The provision of implant overdenture treatment within the Dutch National Health Service system is common and has

been evaluated extensively, demonstrating favorable objective and subjective results.⁷⁻⁹

The higher rate of edentulism and a more established tradition of removable prostheses in the Netherlands than in Sweden may further explain the great difference between these two countries. According to a recent review,¹⁷ the Netherlands belongs to the group of countries with the highest rates of edentulism. This may also explain the 2 to 11 times higher prevalence of edentulous mandibles among the Dutch implant patients than in the other countries. The very low prevalence (7%) in Japan may be explained by the fact that edentulism is rare among subjects aged 50 to 60 years, the most common group in Japan asking for implant treatment. In comparison to the relatively few mandibular implant overdentures fabricated in Japan in 2001, the number is rapidly increasing, especially since immediate/early loading has begun to be used in accordance with recent reports of its feasibility.¹⁸

The ratios in the other countries of overdentures to total implant treatment of edentulous mandibles varied between one and two thirds (except for Greece, with a value close to that for Sweden). This indicates an ongoing international dissemination of the overdenture approach. An important reason for this development, according to the present survey, is the reduced cost for overdentures in comparison to fixed prostheses. It has been suggested that the considerable maintenance requirements for implant overdentures demonstrated in several short to medium-long studies^{16,19-22} may level out the initial cost difference between fixed and overdenture implant treatment. However, a recent cost-minimization analysis showed that over a 9-year period, overdenture implant therapy for edentulous patients is a more cost-effective treatment compared to fixed implant-supported prostheses.²³

A way to diminish the cost of implant treatment is to reduce the number of implants. Instead of the original protocol with six implants,¹⁵ more recent long-term studies have demonstrated that four implants are sufficient to support a fixed mandibular prosthesis.^{24,25} Promising short-term results with only three implants for fixed mandibular implant-supported prostheses have been presented.²⁶⁻²⁸ A randomized clinical study comparing fixed mandibular prostheses on three implants and overdentures in the edentulous mandible over 1 year found relatively small differences in cost between the two treatment options.²⁹ Those authors conclude, therefore, that the choice between a fixed and removable implant prosthesis need not be a matter of economy. This opinion is probably common among Scandinavian prosthodontists. Internationally, however, the overdenture approach seems to have a strong standing at present.^{23,30}

A majority of the respondents thought that patients would be equally or more satisfied with implant

overdentures as with fixed prostheses. This has also been demonstrated in a controlled study: As many patients who were given the opportunity to choose between an overdenture and a fixed prosthesis chose the removable as the fixed alternative.³¹ It is therefore somewhat surprising that there is such a poor correlation between these opinions of high satisfaction with overdentures and the ratios of performed implant treatment. This indicates that many factors are involved in prosthodontic decision making, of course also including a number of variables influencing the patient's choice of prosthodontic treatment.³²

There was a great variation in anchorage system used for the implant overdentures both between countries and within each country (except for the single clinic in Canada that only uses one system). This variation was not surprising, since longitudinal clinical studies have not found any significant differences in survival rate, peri-implant tissue health, and marginal bone loss related to retention system.³³⁻³⁸ In contrast, *in vitro* studies have found differences in load transfer and denture stability among ball, magnet, and bar attachments.^{39,40} However, the clinical consequences of these differences are difficult to interpret. As usual, the best evidence has to be looked for in long-term clinical investigations. The choice is complicated and should include an evaluation of other factors as well, such as initial cost, after care, and total cost; simplicity; hygienic aspect; and retention capacity.^{20,23,41}

An important question in this type of survey is how representative the results are for implant treatment in the 10 countries. The previous Swedish survey¹⁴ concluded that the results well represented the present situation (in 2001). This was based on the fact that most implant treatment of edentulous patients in Sweden is performed in specialist clinics, and 93% of them responded to the questionnaire. In Japan, the response rate was even higher, but the survey was limited to Kyushu. This island in the south of Japan has 12,000,000 inhabitants, corresponding to approximately 10% of the total population of Japan. There is no reason to assume that the results should not be representative of the whole country. In Korea, six clinics well-known for implant treatment in Seoul were selected, and five of them cooperated. There are 13,000,000 people living in Seoul, corresponding to 25% of the Korean population. The capital has 60% of the implant market, which is rapidly growing. Fixed implant prostheses also have a long tradition in Finland, which explains the ratio between fixed and removable prostheses. However, only the members of the implant society, most of whom are specialists, were included in the study. Implant treatment is performed by many general practitioners as well, and one may assume that overdenture therapy may be more

common in Finland than the questionnaire figures indicate.

The varying number of participants in the 10 countries indicates the difficulty of finding representative clinics to include in the survey. The variation regarding number of clinics and treatments undertaken as well as response rate indicates that the results must be interpreted with caution. Another weakness of the study is the type of simple questions used, which does not allow an in-depth analysis of the results. However, even a careful interpretation suggests great variation among the countries concerning implant overdenture treatment. It has been suggested that implant overdentures are likely to replace conventional dentures as the preferred mode of prosthetic rehabilitation for edentulous patients. This road has obviously been taken by the Netherlands, with a ratio of overdentures to total implant treatment of the edentulous mandible of 93%; according to this survey, however, this ratio exceeded 50% in only two more countries, the UK and Singapore, and was close in another two, Canada and Korea. The enormous development in implant treatment during the past 20 years will certainly continue, but its direction is not evident.⁴² However, implant overdentures will most probably play an important role in treatment of edentulous jaws in many countries. To obtain a more global assessment of this development, surveys similar to the present one will be needed in more countries in the near future. Of great interest will be continuing epidemiologic surveys on edentulism and demographic changes and evaluations of need and demand for implant treatment.

Within the limitations of this preliminary international survey, it may be concluded that there are great differences among the 10 included countries in the choice of implant treatment of the edentulous mandible. Tentative explanations of the differences include variations in dental education, prosthodontic tradition, economic factors, and dental insurance. More research will be needed to allow further in-depth analysis of the results.

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Literature Abstract

Evaluation of the mechanical characteristics of the implant-abutment complex of a reduced-diameter Morse-taper implant.

This nonlinear finite element stress analysis evaluated the mechanical characteristics of the implant-abutment connection of a reduced-diameter ITI dental implant. A finite element model of a 3.3 mm diameter \times 10 mm ITI solid-screw implant and a 6-degree solid abutment 4 mm in height was constructed; the implant-abutment complex was embedded vertically in the center of a 1.5 cm diameter \times 1.5 cm acrylic cylinder. Static vertical and oblique loads of 300 N were applied in separate load cases. Contact area was defined between the implant-abutment connection, and nonlinear finite element stress analysis was performed. In vertical loading, von Mises stresses concentrated around the implant-abutment connection at the stem of the screw and around the implant collar. Oblique forces resulted in a twofold increase in stresses at the implant collar, which was close to the yield strength of the titanium. Displacement values under both loading conditions were negligible. The authors concluded that, in a reduced-diameter ITI implant, vertical and oblique loads are resisted mainly by the implant-abutment joint at the screw level and by the implant collar. The neck of this implant is a potential zone for fracture when subjected to high bending forces. The authors recommend that the diameter of the implant be increased, or the diameter of the abutment screw be reduced, to reduce the risk of implant fractures.

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