A Retrospective Evaluation of Treatments with Implant-Supported Maxillary Overdentures

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ABSTRACT

Background: Considerably lower success rates have been presented for implant-supported overdentures in the maxilla compared with the mandible.

Purpose: The aim of the study was to report the outcome of implant-supported maxillary overdentures from one clinic.

Methods: All patients treated with implant-supported maxillary overdentures in the Department of Prosthetic Dentistry, Central Hospital, Skövde, Sweden, between 1993 and 2002 were identified from patient charts and included in the study. All patients had a rigid cast gold alloy bar designed with ball attachments retaining an overdenture.

Results: Twenty-seven subjects were included, of whom 13 were originally planned for overdenture treatment (group 1) and the other 14 for a fixed prosthesis (group 2). The mean observation period was 5.7 years for subjects in group 1 and 5.5 years for those in group 2. One hundred forty-five implants were placed, and the majority of the failures were diagnosed as early ones and were found in group 2. The cumulative implant survival rate after 5 years was 77% in group 1 and 46% in group 2. The probability of having implant failure was almost three times higher among subjects in group 2 compared with subjects in group 1. Most technical and biologic complications were related to the retention system.

Conclusion: Maxillary implant-supported overdentures show a high implant failure rate, but fewer implant failures occurred for patients originally planned for overdenture treatment.

KEY WORDS: dental implant, implant failure, maxilla, overdenture

The use of dental implants for prosthetic rehabilitation of the edentulous jaw is a predictable and successful treatment modality.[1–3] Implant-supported fixed and removable prostheses in the mandible have shown excellent long-term results.[1,4–8] Lower success rates are reported for the maxilla, especially for overdenture treatment.[9–15] Treatments with implant-supported overdentures seem to be influenced by different prosthodontic traditions and financial considerations related to regulations in dental insurance systems.[16,17] Factors related to aesthetics, oral function, and speech are also considered important, especially when planning for overdenture treatment.[18–20]

In general, poor bone quality and bone volume, short implant length, and poor initial stability are factors associated with the lower success rate for implants in the maxilla compared with the mandible.[4,20,21] Because of the lower bone density, splinting of implants in the maxilla using a rigid bar connector has been suggested to reduce unfavorable loading.[20,22–24] Nevertheless, reports indicate higher bending moments for maxillary implants splinted by a bar compared with implants supporting a fixed rigid prosthesis.[25]

Different retention systems for implant-supported overdentures have been presented in the literature.[7,8,23] Whereas unsplinted systems, such as various types of ball attachments, have been frequently used in the mandible, prefabricated bar systems in combination with clips for denture retention seem to be the most preferred concept in the maxilla.[11,14,23,24,26]

The number and position of the implants are factors that may influence loading conditions and treatment

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outcome. This is especially important in the maxilla because the bone density generally is poorer than in the mandible. Moreover, overdentures reinforced with a cast metal framework or designed with a full palatal plate can reduce denture deformation, which consequently leads to a lower risk of unfavorable force distribution to the implants.[27] Reports show higher survival rates in patients originally planned for maxillary implant-supported overdentures compared with unplanned or rescue treatments.[11,14]

The objective of the present study was to retrospectively evaluate outcome in two groups of patients treated with implant-supported maxillary overdentures. Various factors related to the treatment were compared among subjects in the two groups.

MATERIALS AND METHODS

All patients treated with implant-supported maxillary overdentures in the Department of Prosthetic Dentistry, Central Hospital, Skövde, Sweden, between the years 1993 and 2002 were identified from patient charts and included in the study. The following information was available and included

- Patient age and gender
- Previous dental and medical history and smoking habits
- Originally planned prosthodontic treatment: implant-supported overdenture (group 1) or implant-supported fixed prosthesis (group 2)
- Oral status of the mandibular arch
- Observation period
- Number, length, and positions of implants
- Number and length of implants lost before (early failures) and after loading (late failures)
- Overdenture design
- Technical and soft tissue complications

For subjects in group 2, overdenture treatment was chosen because of an insufficient number of implants to support a fixed prosthesis owing to early failures or poor bone volume. The oral surgeon was responsible for the assessment of alveolar bone available for implant placement. All patients who experienced implant failures were offered the possibility of bone grafting to place additional implants for a fixed prosthesis if there were no contraindications to such a procedure. The other option presented to the patients was treatment with an implant-supported overdenture.

Follow-up visits were scheduled 12 months after completed prosthodontic treatment and every second year thereafter. The clinical examination included evaluation of denture-supporting soft tissue and the mucosa adjacent to the implants and the bar, denture retention and stability, and occlusion. On all patients, Brånemark System® Mk II implants (Nobel Biocare AB, Göteborg, Sweden) were placed by experienced oral surgeons following the traditional surgical protocol.[28]

Prosthodontic Treatment

All patients were provided with a rigid cast gold alloy bar (Protor 3, Type 4, Cendres' Metaux, Biel-Bienne, Switzerland) to splint the implants. The bar was designed with two ball attachments (OT Cap, Rein 83, Bologna, Italy) placed close to the implants in the position of the lateral or canine teeth to allow for a hinge axis movement in the denture (Figure 1). No bars were designed with distal extensions. Spacers were used to permit vertical movement to achieve support mainly from the soft tissue when the denture was loaded. The retention of the denture was enhanced by replaceable resilient nylon caps (Figure 2). Five different types of resilient caps were available, ranging from soft to firm retention.

Depending on factors such as loading conditions, gag reflexes, oral comfort, and patient preference, different overdenture designs among the subjects were chosen (Table 1).

Statistical Methods

Descriptive statistics were used for the evaluation of data. The life table method was used to calculate the

Figure 1 Occlusal view of the bar designed with two ball attachments.

Figure 2 Maxillary overdenture with two housings and nylon caps.

survival and cumulative implant survival rates.[29] Cox's regression method was used for analysis of implant survival with respect to patient's age, gender, implant length, smoking habits, and planned overdenture treatment. Statistical significance was set to $p \leq .05$. All data analysis was done in *SPSS* (SPSS Inc., Chicago, IL).

RESULTS

Thirty-one subjects were treated with maxillary implant-supported overdentures. Four of these patients were lost to follow-up because they died shortly after the treatment was completed. All data from these subjects were deleted from the study. Of the remaining 27 subjects, 14 were men and 13 were women, with a mean age of 63.3 years (range 46–76 years). Thirteen subjects, 6 men and 7 women, with a mean age of 62.4 years, were originally planned for overdenture treatment (group 1), and the other 14, of whom 8 were men and 6 were women, with a mean age of 64.0 years, were planned for a fixed prosthesis (group 2). The mean observation period was 5.7 years (range 2.0–7.3 years) for subjects in group 1 and 5.5 years (range 0.5–9.3 years) for subjects in group 2.

The majority of the 145 implants were placed in subjects originally planned for a fixed prosthesis (group 2; Table 2). Sixty-three percent of the implants in that group failed compared with 23% in group 1 (planned overdenture treatment). Five patients, all originally planned for a fixed prosthesis (group 2), lost all of their implants and received treatment with complete upper dentures. Four of the subjects lost their implants during the first year, whereas one lost the implants after 2 years. Most of the complications were diagnosed as early failures in both groups (see Table 2). The cumulative implant survival rate after 5 years was 77% for subjects in group 1 and 46% for those in group 2 (Table 3). Using the Cox regression model with implant survival as the dependent variable, the probability of having implant failure was almost three times higher among subjects in group 2 compared with subjects in group 1, $p \leq .002$ (Table 4). The number of smokers was nine, of whom five were in group 2 and four were in group 1.

The number of technical and biologic complications and denture adjustments is presented in Table 5. Most technical complications were related to the retention system. The number of nylon cap replacements was high, and the mean time in service was 21.5 months in group 1 and 18 months in group 2. The proportion of subjects with soft tissue hyperplasia adjacent to the alveolar bar increased with time. At the 5-year examination, such hyperplasia was observed in 67% of the subjects in group 1 and 40% of the subjects in group 2 (Table 5).

DISCUSSION

There are several reports indicating a high number of complications related to overdenture treatment.[9–12] In the present study, the number of failed implants was high. The cumulative implant survival rate after 5 years was 77% for subjects originally planned for an overdenture (group 1) compared with 46% for subjects planned for a fixed prosthesis (group 2). However, for subjects in group 2, several late implant failures occurred, and the cumulative implant survival rate after 8 years dropped to 38% (see Table 3). The results for group 1 resemble those found by Jemt and colleagues, who reported a cumulative success rate of 72% after 5 years.[13] The total implant failure rate in group 2 was

TABLE 1 Distribution and Design of Maxillary Overdentures

	No. of Overdentures	
Design	Group 1 (n = 13)	Group 2 (n = 14)
Cobalt chromium framework (palatal strap)	4	7
Cobalt chromium framework ("horseshoe")	—	1
Acrylic resin (full palatal plate)	9	6

TABLE 2 Length and Distribution of Placed and Failed Implants among Subjects in Group 1 and 2, Respectively

	Group 1 (n = 13)			Group 2 (n = 14)		
	No. Placed (%)			No. Placed (%)		
Implant Length (mm)	Early	Late	No. Failure (%)	Early	Late	No. Failure (%)
7	—	—	—	1	—	—
10	14	2	1	19	10	5
11.5	1	—	—	—	—	—
13	21	3	1	45	19	6
15	14	—	3	26	12	5
18	3	3	—	1	1	—
Total	53	8 (15)	5 (8)	92	42 (46)	16 (17)

60%, which was three times higher than for subjects in group 1 (see Table 2). This result is in accordance with findings in previous studies on overdenture therapy in the maxilla, which included planned and "rescue" treatments. In a study by Palmqvist and colleagues, the implant failure rate in the "emergency group" was 72%,[14] and another study also showed high failure rates (55%) among subjects originally planned for a fixed prosthesis in the maxilla.[11] Those findings should be considered when evaluating the result from the Cox regression analysis in the present study, which showed that the probability of having implant failure was almost three times higher among subjects who were not originally planned for overdenture treatment ($p \leq .000$; see Table 4).

Five patients, all in group 2, lost all of their implants. Four of the complete failures occurred during the first year of loading, and one patient lost the implants 2 years after denture delivery. The subjects received complete upper dentures because they did not want any additional implant treatment. In a prospective study including 30 subjects with bar-retained maxillary implant-supported overdentures, 6 individuals lost all implants, mainly during the first year of follow-up.[13] Similar results were found in a retrospective follow-up study, in which complete failures occurred in 4 of 30 patients.[11] Also in that study, the implants were splinted using a bar.

When evaluating treatment outcome of implant-supported maxillary overdentures, early failures are

TABLE 3 Life Table Analysis of Implants in the Two Groups (n = 27)

	No. of Implants		No. of Implants Exposed to Risk		No. of Failed Implants		Proportional Survival Rate (%)		Cumulative Survival Rate (%)	
Observation Period (mo)	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
≤ 12	53	92	53	92	7	33	87	64	87	64
13–24	46	59	46	59	1	10	98	83	85	53
25–36	45	49	45	49	3	2	93	96	79	51
37–48	42	47	40.5	47	1	3	98	94	77	48
49–60	38	44	36	44	0	2	100	95	77	46
61–72	34	42	33	42	1	2	97	95	75	44
73–84	31	40	24.5	40	0	4	100	90	75	39
85–96	18	36	11	31.5	0	1	100	97	75	38
97–108	4	26	2	19	0	0	100	100	75	38
109–120	—	12	—	8.5	—	0	—	100	—	38
121–132	—	8	—	5.5	—	0	—	100	—	38

TABLE 4 Cox Regression Model with Implant Survival as the Dependent Variable (*N* = 145)

Independent Variable	b	OR	*p*
Age	0.04	1.00	.854
Gender	−0.36	0.69	.171
Planned overdenture	0.99	2.71	.002
Smoking	−0.36	0.69	.384
Implant length	0.04	1.04	.551

OR = odds ratio.
Model chi-square: 23.654, 7 df, $p \leq .001$.

predominant.[10,11,14] Although the mean number of placed implants was higher in group 2, the number of early implant failures was higher than in group 1, and the same was true for failures after loading (see Table 2).

Unfortunately, there was a lack of information about bone quality and quantity for some of the patients; therefore, those variables could not be considered when evaluating factors associated with failing implants. An important factor, however, is the implant length, and in previous studies on overdentures, 7 and 10 mm implants dominated among those that failed.[9,10] In the present study, the majority of the placed implants were 10, 13, and 15 mm long. Eighty percent of the 10 mm implants failed in group 2, whereas the corresponding figures for 13 and 15 mm implants were 56% and 65%, respectively (see Table 2). In group 1, 20% of the 13 and 15 mm implants failed. Although the main reasons for choosing overdenture treatment usually are related to factors associated with severe alveolar ridge atrophy, careful treatment planning is important and improves treatment outcome.[20]

A variety of bar designs and retention system have been used in treatments with maxillary implant-supported overdentures.[9–14] It has been suggested that the occlusal load will be more favorably distributed when the implants are splinted using a rigid bar compared with a situation with separate implants.[20] Moreover, from a biomechanical point of view, a bar is advised when restoring divergent implants.[20] In the present study, all patients were provided with the same type of rigid cast gold alloy bar on which two ball attachments were placed. However, compared with studies in which a round prefabricated bar was used, the type of design used in this study did not seem to have any impact on the number of lost implants after loading because the failure rate was similar.[11,12,14]

Although the same gold alloy and retention system was used on all patients, great variations were observed concerning the number and types of technical complications (see Table 3). In 10 subjects, of whom 7 had overdentures designed with a palatal strap, replacement of the ball attachments on the bar was necessary because of severe wear (Figure 3). It was somewhat surprising that such extensive wear was found on the ball attachments in more than a third of the subjects, even though resilient nylon caps were used for retention. Although all bars and ball attachments were fabricated using hard gold alloy (Protor 3, Type 4), an even harder

TABLE 5 Distribution of Denture Adjustments and Technical and Biologic Complications in the Two Groups (*n* = 27)

Complication	Group 1 (*n* = 13)	Group 2 (*n* = 14)
Replacement of resilient nylon cap	83	84
Replacement of ball attachment	5	5
Denture base adjustment	2	9
Denture tooth fracture	3	2
Denture base fracture	5	12
Denture relining	14	17
Loose abutment screw	1	2
Hyperplasia of the mucosa adjacent to the bar		
Year 1 examination*	1 (8)	2 (13)
Year 3 examination*	4 (33)	4 (27)
Year 5 examination*	8 (67)	6 (40)

*Values in parentheses indicate percentage distribution with respect to the number of valid observations.

Figure 3 Severe wear of ball attachments fabricated in type 4 gold alloy.

and more wear-resistant metal alloy probably would reduce the need for maintenance.

A great number of complications related to the resilient nylon caps were also observed (see Table 3). Compared with metal clips, the system using a resilient cap as retention is advantageous because it is less expensive and the nylon cap can easily be replaced chairside. However, reports indicate a lower frequency of technical complications with metal clips when compared with other types of resilient retention systems.[9,11,15] The time interval between replacing the caps varied among the subjects. Five patients had satisfactory denture retention for more than 5 years and did not request any replacement, whereas five patients required replacement of the caps every second month owing to unsatisfactory retention. However, it is difficult to assess the proper degree of denture retention for each patient because this is highly individual. The mean time in service before cap replacement was 21.5 months for group 1 and 18 months for group 2. A precise fit of the denture is necessary to avoid movement and rocking, which otherwise could cause damaging wear of the retentive components.[20] Thus, a proper denture extension, including a full palatal plate design and regular evaluations of the denture fit, is recommended to reduce the risk of wear. Further, the need for relining should be recognized, and the dentist and the patient should be aware of the need for ongoing maintenance when considering this type of treatment.

It is well known that the mucosa often proliferate under the denture base, although good oral hygiene is maintained.[9–11,14,15] In a longitudinal study on implant-supported overdentures, an increased frequency of hyperplasia in the maxilla of 30% over a 5-year observation period was reported.[15] In a retrospective follow-up study, hyperplasia was observed in 64% of the subjects originally planned for a fixed maxillary prosthesis but who had an overdenture treatment because of implant failure.[11] Similar results were found in the present study, in which hyperplasia of the mucosa adjacent to the bar increased with time and was more common among subjects in group 1 than in group 2 (see Table 5). However, owing to the small sample size, the differences were not statistically significant. Most of the patients were old, and some of them had problems with maintaining proper oral hygiene because of the hyperplasia. However, no signs of periimplant mucositis were observed.

CONCLUSION

The results from the present study support findings in similar investigations that treatments with implant-supported overdentures show a high implant failure rate. However, less implant failures occurred for patients originally planned for overdenture treatment, an important aspect when considering such treatment in the maxilla. Because of the complexity of overdenture therapy, careful treatment planning should always be done to improve treatment outcome. The high number of technical complications related to the attachment system indicates a need to further develop and improve such systems designed for overdenture treatment.

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