

Rehabilitation of Patients with Severely Resorbed Maxillae by Means of Implants With or Without Bone Grafts: A 3- to 5-Year Follow-up Clinical Report

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Forty-three patients with severely resorbed maxillae who had been referred for implant treatment were assigned to 1 of 3 treatment options: bone grafting and implant placement (graft group), modified implant placement with no bone grafting (trial group), or optimized complete dentures (no-implant group). Sixteen, 20, and 7 patients, respectively, were assigned to the 3 groups. The patients have been examined annually, and at the time of this report they had been followed for 3 to 5 years after treatment. At the 1-year follow-up, 10% (22 of 221) of the implants had been lost, and at the 2-year follow-up, 18% of the implants had been lost (40 of 221; 25% in the graft and 13% in the trial group); after that time, no further losses occurred. Life table analysis showed cumulative success rates of 82% in the graft group and 96% in the trial group after 1 year, and 74% and 87%, respectively, at the final examination after 3 to 5 years. The failure rate was higher in smokers than in non-smokers. A substantial reduction of the grafted bone, especially of onlay grafts, occurred early after grafting surgery in many patients. Mean marginal peri-implant bone loss was 0.6 mm during the period from prosthesis connection to the 1-year follow-up, and from the 1-year to the 3-year follow-up, average peri-implant bone loss was 0.3 mm in the graft group and 0.5 mm in the trial group. The results corroborated previous findings that patients with severely resorbed maxillae have an increased risk of implant failure in comparison to patients with good bone quantity and quality. However, in this investigation, practically all implant losses occurred during the first 2 years, whereupon a steady state seemed to follow for up to 5 years after loading. (INT J ORAL MAXILLOFAC IMPLANTS 2001;16:73-79)

Key words: bone graft, bone resorption, dental implants, oral radiography, osseointegration, sinus inlay

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Implant treatment in patients with severely resorbed maxillae is a demanding procedure, and the failure rate has been reported to be higher than for implants placed in other types of jawbone.¹⁻⁴ When the bone volume is not sufficient for conventional implant treatment, various grafting procedures have been advocated.⁵⁻¹⁴ The success rates have been excellent to moderate but have varied more than for conventional implant treatment.^{3,15-18} Cigarette smoking appears to be detrimental to the success of osseointegrated implants in grafted maxillary sinuses.¹⁹

Another way to compensate for severe maxillary resorption has been to modify the conventional implant method, eg, by means of modifications of

Table 1 Age and Gender Distribution of the Patients in the 3 Treatment Groups

Patient age (y)	Graft group		Trial group		No-implant group		Total
	M	F	M	F	M	F	
50 or under	0	2	1	4	0	1	8
51–60	4	2	1	6	1	1	15
61–70	2	5	4	1	1	1	14
71 or over	0	1	1	2	1	1	6
Total	6	10	7	13	3	4	43

M = male; F = female.

the drilling technique or placement of the implants in the maxillary tuberosity or zygomatic region.^{14,20,21} The results available today of most of the presented methods are primarily short-term, and follow-up periods exceeding 5 years are rare. It has therefore been suggested that “detailed follow-up studies are necessary for continued advancement of bone graft techniques utilizing implants.”¹⁵

Previously,²² a 1-year follow-up of 43 patients with severely resorbed maxillae assigned to 3 treatment groups was described: 2 groups were treated using implants—one with bone grafts, the other without bone grafts but with modifications of the conventional implant technique—and the third group was treated only with optimized complete dentures. The purpose of the present study was to evaluate, clinically and radiographically, the longer-term outcome of the rehabilitation of these patients with respect to implant and bone graft survival, peri-implant bone resorption, prosthodontic rehabilitation, and patient assessment of the treatment.

The study was designed according to the Declaration of Helsinki and accepted by the Ethical Committee, Medical Faculty, Göteborg University.

MATERIALS AND METHODS

The patients in this study were selected from those who, during a specified time period, were referred to the Clinic of SIM-Prosthetic Dentistry, Mölndal, Sweden, for implant treatment in the maxilla. A detailed description of clinical and radiographic examination as well as surgical and prosthodontic treatment procedures was published previously.²² Briefly, all patients who, after a radiographic examination, were judged to have insufficient bone for conventional implant placement were presented with detailed information about 3 treatment options: a grafting procedure combined with

implants (graft group), a modification of implant placement but without bone grafting (trial group), or an optimized complete denture (no-implant group). After patients were given appropriate information and had discussed the options with their dentist, 16 patients were assigned to the graft group, and 20 were assigned to the trial group; the remaining 7 patients renounced any implant treatment and were assigned to the no-implant group. The age and gender distributions of the patients are presented in Table 1. Two patients in each of the implant groups were partially edentulous; those remaining were completely edentulous in the maxilla. All patients in the 2 implant groups had natural teeth or an implant-supported restoration in the mandible, although the dentition often was reduced. One patient in the no-implant group had a mandibular complete denture; the others had natural teeth without removable prostheses.

Evaluation of Bone Quality and Quantity

The radiographic evaluation showed that all patients had lost so much bone that conventional implant treatment was judged to be impossible. The great majority of the patients had a jawbone shape corresponding to D or E in the Lekholm and Zarb classification of bone quantity and type 3 or 4 bone quality.²³ On average, the patients in the graft group had more severe bone loss than those in the trial group (median values D/4 and D/3, respectively).²²

Surgical Procedure

The operations were performed between April 1991 and September 1994. Details of the surgical procedures were presented previously.²² One-stage grafting procedures were most common, with bone harvested from the iliac crest. A total of 221 implants were placed in 36 patients: 101 in the graft group and 120 in the trial (ie, non-graft) group. Of the 101 implants in the graft group, 68 were placed at

the time of bone grafting, and 33 were placed secondarily in consolidated grafts (3 to 4 months after grafting). The majority (69%) were self-tapping implants. Distributions of the type, length, and diameter of all implants placed were presented previously.²² In the trial group, the unconventional approaches for implant placement included acceptance of free implant threads to be covered with bone chips and membranes for guided tissue regeneration, unusual implant positions, eg, buccal to the incisive canal, and small-diameter implants.

Prosthodontic Procedure

Abutment connection was performed 6 to 8 months after implant placement in all patients in both groups. The prosthetic treatment was started about 1 week later and generally followed the standard protocol of the Brånemark System (Nobel Biocare, Göteborg, Sweden).²⁴ The aim was to provide the patients with a fixed implant-supported prosthesis, but when the situation was unsuitable, an overdenture was chosen. Fixed prostheses were more common among the implant-supported restorations than overdentures (13 fixed, 3 overdentures in the graft group and 15 fixed, 5 overdentures in the trial group).

The fixed prostheses were fabricated with a gold alloy frame and acrylic resin teeth and bases. The overdentures were fabricated of acrylic resin and a cast cobalt-chromium framework. The retention system consisted of bars between the implants and clip attachments (Nobel Biocare) placed in the dentures. A balanced occlusion concept was sought, as far as possible, for the overdentures, while a group contact occlusion without balancing side contacts was utilized for the fixed prostheses.

Examinations

Patients in the implant groups were clinically examined according to a specified protocol at the time of prosthesis connection and annually thereafter. All patients were invited to a final follow-up visit approximately 5 years after completion of the treatment of the first few patients in the series. At this examination, all patients had been followed for at least 3 years. Clinical recordings comprised assessment of soft tissues around the implants, bleeding on probing, occlusion and wear of the artificial teeth, and any failures and/or complications related to implants and prostheses. At the 1- and 3-year follow-ups, the patients were asked to answer a few questions about treatment outcome. Pretreatment and current masticatory ability were assessed by means of a visual analog scale (VAS) graded 0 to 10. A specialist in prosthodontics who had not participated in the treatment performed the 1-year and

the 3- to 5-year follow-up examinations. The patients in the no-implant group were not clinically examined at the follow-ups, but were instead interviewed by telephone with the same questionnaire used for the implant patients.

For the evaluation of success and failure, suggested criteria^{25,26} were followed. However, the prostheses were not removed when testing for mobility, unless this was considered necessary for repair or correction.

Statistics

Life table analysis was performed to calculate the cumulative success rate (CSR) of implant and prosthesis stability.²⁵⁻²⁷

RESULTS

In the graft group, 3 of the 16 patients were regarded as total treatment failures because all their implants (9, 6, and 6, respectively) lost osseointegration. Two of these patients have been reoperated, but at the time of the final follow-up, the third patient refused to have the prosthesis removed, even though it was supported by non-integrated implants according to the radiographic examination. Another patient was reoperated because of loss of 3 implants and had 3 new implants placed 2 years after prosthesis placement. Only the originally placed implants were included in the material. One patient demanded to have her fixed prosthesis removed after a few months and went back to a complete denture because of psychologic reasons (the implants have been left as "sleeping").

In the trial/non-grafted group, 4 patients were withdrawn: 2 patients died after 1 and 2 years, respectively, 1 moved to another part of the country, and 1 patient did not wish to come for any follow-up examination after the prosthodontic treatment. Implant losses in this group occurred in 6 patients. Four of these failures were observed at the time of abutment operation, 1 happened during the first year, and 10 occurred during the second year after prosthesis connection. No further losses of implants were noted during the remaining observation period in this group. Three patients were reoperated and additional implants were placed, but only the originally placed implants were accounted for in the report (Table 2).

Implant Survival

At the 1-year follow-up, 22 of 221 placed implants (10%) had failed, 17 (17%) in the graft group and 5 (4%) in the trial group. During the whole observation period, 18% (40/221) of the implants were lost,

Table 2 Life Table Analysis of Placed and Followed Implants in the Graft Group and the Trial Group

Time period	No. of implants	No. failed	No. withdrawn	CSR (%)
Graft group				
Placement to loading	101	14	0	86.1
Loading to 1 year	87	3	0	82.2
1 to 2 years	83	7	9	75.2
2 to 3 years	67	1	0	74.1
3 to 4 years	66	0	0	74.1
4 to 5 years	33	0	0	74.1
5 years	15	—	—	—
Trial group				
Placement to loading	120	4	0	96.8
Loading to 1 year	116	1	10	95.8
1 to 2 years	105	10	11	86.7
2 to 3 years	84	0	0	86.7
3 to 4 years	84	0	7	86.7
4 to 5 years	61	0	0	86.7
5 years	44	—	—	—

CSR = Cumulative success rate.

25% (25/101) in the graft group and 13% (15/120) in the trial group. Two thirds of the losses involved shorter implants (10 mm or shorter). Life table analysis (Table 2) revealed a cumulative success rate (CSR) of 82% in the graft group and 96% in the trial group after 1 year; these had dropped to 74% and 87% at the final follow-up (3 to 5 years).

The failure rates in the graft group of implants placed by 1-stage and 2-stage procedures were similar. They were 19% (13/68) and 12% (4/33), respectively, after 1 year, and 25% (17/68) and 27% (9/33) at the 3- to 5-year follow-up.

More implants were lost in smokers than in nonsmokers. In the graft group, the failure rate was 74% (17/23) in the 3 smokers and 10% (8/78) in the 13 nonsmokers. In the trial/non-graft group, the difference was smaller: 20% (9/44) in the 8 smokers and 11% (6/53) in the 12 nonsmokers. When both groups were taken together, the failure rate differed markedly: 39% among the smokers, and 11% among the nonsmokers.

Marginal Bone Level and Peri-implant Bone Loss

The bone level was on average 2.3 mm apical to the implant-abutment junction at the time of prosthesis placement in the graft group and 2.5 mm in the trial group (difference between groups not significant). The range was large (0.0 to 7.0 mm) and similar in the 2 groups. The marginal bone loss during the observation period did not differ significantly

between the groups. It was on average 0.6 mm from prosthesis connection up to the 1-year follow-up, and a further 0.3 mm in the graft group and 0.5 mm in the trial group between the 1- and 3-year radiographic examinations after prosthesis placement.

Prosthesis Stability

At the last follow-up, all patients remaining in the study were wearing their implant-supported prostheses (except the patient who did not want a fixed prosthesis for psychologic reasons). In addition, the 2 patients in the graft group and 3 patients in the trial group who received new implants after losses now have implant-supported prostheses.

Questionnaire

The patients evaluated their masticatory ability as much improved after the treatment, with similar values in the 2 groups at the 1-year and final follow-up examinations (Table 3). The mean values for all patients according to the VAS assessment were 3.0 before treatment and 8.3 both at the 1-year and final follow-up examinations. The frequent initial phonetic problems after treatment were reduced at the final examination, when 3 patients in the trial group and no patients in the graft group had remaining problems (2 reported lisping, and 1 considered the anterior part of the prosthesis too bulky). Eighty percent of the patients in both groups were satisfied with the esthetic result of the treatment. When asked at the final follow-up, all patients in each

Table 3 Self-Assessed Masticatory Ability* (Mean and Range)

Treatment group	Before treatment		1-year exam		Final exam	
	Mean	Range	Mean	Range	Mean	Range
Graft group (n = 16)	3.1	0 to 7	8.7	6 to 10	8.6	6 to 10
Trial group (n = 20)	2.9	0 to 9	7.9	5 to 10	8.0	5 to 10
No-implant group (n = 7)	—	—	5.8	5 to 9	6.0	5 to 9

*On a visual analog scale, with a range between 0 (no masticatory ability) and 10 (excellent masticatory ability).

group expressed willingness to undergo the treatment again, in spite of the difficulties and problems involved. However, 1 patient said he would not have a sinus inlay operation performed again.

The patients in the no-implant group assessed their mean masticatory ability as 5.8 according to the VAS at the 1-year follow-up, and 6.0 at the 3- to 5-year follow-up. Of the 6 patients who answered the questionnaire at the last follow-up, 2 said their mastication functioned well, 2 fairly well, and 2 said it was problematic.

These patients' reasons for refraining from implant treatment varied, but fear of complications, the amount of time required, and the expense of treatment were mentioned most often. Four of these patients said at the final follow-up that they would still refuse implant treatment, but 2 would now like to have implants placed.

Clinical Examinations

Soft tissue lesions were rare. At the final follow-up, gingival bleeding around implants was recorded at only a few sites in 4 patients in the trial group. This was slight improvement compared with previous registrations. Two patients had purulent exudate around a solitary implant, 1 patient exhibited stomatitis under an overdenture, and 1 demonstrated hyperplasia in association with an overdenture. Tooth wear varied somewhat between the patients, but none exhibited extensive wear. Three patients in the graft group and 2 in the trial group had a prenormal (Angle Class III) jaw relationship. Group contacts in lateral excursions were the most frequent occlusal pattern, but balanced occlusion and canine guidance were also recorded, without any marked differences between the treatment groups.

Complications

The occurrence of hip donor site morbidity was low, as documented in the 1-year report,²² and no

patient reported any recurring problems during the remaining observation period.

The most serious complications were related to the loss of grafts and implants described in the 1-year report.²² Aside from the need to fabricate new prostheses for the patients with multiple implant losses, only minor prosthodontic problems were encountered, and they were managed by means of ordinary clinical and laboratory procedures.

DISCUSSION

Implant treatment of severely resorbed maxillae is a demanding procedure, both for patients and for clinicians. The failure rate is higher than in routine treatment of patients with adequate residual bone volume.^{3,4,15,16} This was corroborated by this investigation, which showed a cumulative success rate of 87% in the trial group (modified implant placement but no bone grafting) and 74% in the graft group. An interesting finding was that practically all implant losses occurred during the first 2 years, and a steady state seemed to follow during the remaining part of the 5-year observation period. The present results suggest that the placement of implants with a modified technique would be preferable to grafting, which usually requires major surgery. Successful use of zygomatic or pterygomaxillary implants has recently been reported, and it has been suggested that such modified implant placement may resolve most cases without grafts, or at any rate involve a smaller grafting procedure.^{14,20,21} After a retrospective review of 542 patients, Meraw et al concluded that grafting was required relatively infrequently (4%) in the general population.²⁸

Infection, impaired healing, and overload have been considered the major factors associated with loss of implants.²⁹ Failures have been divided into early (before loading) or late (after loading). An

analysis of 16 publications on grafting procedures revealed that 62% were early failures and 38% were late failures.³ Similar results (60% early failures) were reported in a recent study of sinus inlay bone grafts, in comparison to 43% early failures in a "normal" reference group.⁴ In the present investigation, the graft group had 54% early failures and the trial group had 27% early failures; these values are relatively similar to the previously reported results.^{3,4}

When the implant failures were divided into biologic, mechanical/technical, iatrogenic, and inadequate patient adaptation, biologic reasons were the most common.³ Even if smoking is now considered a risk factor for implant success according to recent surveys, well-designed clinical trials on the topic are lacking.^{16,29} The effect of smoking on grafted patients has shown conflicting results.^{4,17,19} In the present patient material, a negative influence of smoking was observed, especially in the graft group, where smokers lost ¼ of the placed implants. Even if the results from various studies are somewhat variable, the implications are that the smoking issue should be discussed seriously and resolved.^{16,30}

Rapid and great resorption of the graft has been reported in several studies of bone grafting techniques.^{6-8,31,32} Most of this graft reduction took place during the first few months. In a study that used localized bone grafts from the mandible in the anterior maxilla to support single-tooth implants, an average of 25% and 60% of the graft volume was resorbed after 4 and 10 months, respectively.³³ Similar findings—that in many patients grafts are substantially reduced and that this occurs primarily in the initial postoperative period—have also been documented.²⁴ After the first year, the resorption rate decreased markedly, as has been reported in surveys of other studies.¹⁴

The mean marginal peri-implant bone loss of 0.6 mm up to the 1-year follow-up is remarkably small with respect to the amount of remodeling that the graft undergoes. It was also the same in the grafted and non-grafted groups. One interpretation is that the bone adjacent to the implants is maintained because of proper stimulation, while the more peripheral portions are resorbed because of inadequate stimulus. The peri-implant bone loss from the 1-year to the 3-year follow-up was on average 0.3 mm in the graft group and 0.5 mm in the trial group, which suggests that, after a proper healing time, the grafted bone around the implants will have a prognosis similar to that of non-grafted bone.

It is desirable, and in some countries required by law, to include the patient in the decision-making

during treatment planning in dentistry as well as in medicine. This is probably even more necessary with increasingly uncertain prognoses for various options. The success rates for different treatments of severely atrophied maxillae are not well established. Several studies using different methods have been published in recent years, but the results are difficult to compare because of great variation in techniques and in reporting of the outcomes.^{3,4,15,16} When this study began almost 10 years ago, there was even less evidence on which to base any decision-making. This was one of the reasons the patients were asked to participate in selecting 1 of 3 methods currently available at the clinic at that time for treatment of their severely resorbed maxillae. Patient participation in the planning process may have contributed to the patients' high degree of satisfaction with the treatment, although the outcome was far from 100% successful. Practically all patients, even those who suffered failures, said that they would be willing to undergo the treatment again.

CONCLUSIONS

Implant treatment in patients with severely resorbed maxillae is a demanding procedure, but it can be successful with bone grafting procedures or with modified placement of implants without bone grafts. However, the success rate and implant survival are generally lower and the complication rate is higher than for implants that are placed in arches with better bone quality and quantity, especially in the short-term perspective. In this investigation covering up to 5 years, practically all implant losses occurred during the first 2 years, after which a steady state seemed to follow. The choice of appropriate treatment in borderline cases—bone grafting, modification of conventional implant treatment, or optimized complete dentures—is difficult and influenced by many factors. It was found that it is advantageous to include informed patients in the choice of treatment options.

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