A Retrospective Clinical Study of Wide-Diameter Implants Used in Posterior Edentulous Areas

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Purpose: *The purpose of this study was to examine retrospectively the outcome of wide-diameter dental implants used to retain fixed restorations in the posterior segments of the maxilla and mandible.* ***Materials and Methods:*** *Fifty-two patients were consecutively treated between 1997 and 2000 with 78 Wide-Platform (WP) Mk II implants in the posterior regions of the maxilla and/or mandible. All treated patients were called for a retrospective examination between September and November 2001. At the examination, data regarding general health and clinical and radiographic parameters were collected according to a strict protocol. Thirty-four women and 18 men with a mean age of 55 years (range 19 to 81 years) participated. Twenty-three WP implants were placed in the maxilla and 55 in the mandible. The mean time in situ was 33 months (range of 11 to 58 months).* ***Results:*** *Of 78 implants, 8 had been lost by the time of reexamination. Five women lost 1 implant each in the maxilla, and 2 men lost 3 implants in the mandible. The survival rate was 89.8%.* ***Discussion:*** *The results are encouraging because the WP implants were placed in rather unfavorable situations (generally poor bone quality, compromised bone volume, and larger occlusal forces).* ***Conclusion:*** *Based on the reported survival rate, wide-diameter implants present an acceptable treatment alternative.* INT J ORAL MAXILLOFAC IMPLANTS 2004;19:387–392

Key words: *dental implants, osseointegration, posterior mandible, posterior maxilla, wide-diameter dental implant*

Prosthetic treatment alternatives for treating partial edentulism have included conventional removable partial dentures and fixed partial dentures (FPDs), including resin-bonded FPDs. The goals of treatment planning for posterior implant placement are to correct the loss of posterior support and provide optimal occlusal relations and access for oral hygiene procedures.

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Over the past several decades, rehabilitating edentulous patients with endosseous dental implants has shown excellent long-term results.[1–4] The treatment has demonstrated high predictability and has further encouraged clinicians to extend the indications to partially edentulous individuals. Because of demands for functional, comfortable, esthetically pleasing restorations, interest has been focused on the use of endosseous implants for tooth replacement in posterior segments of the jaws, where first and second molars have been shown to be the most commonly missing teeth.[5]

Several studies have reported on the treatment of partial edentulism with Brånemark System implants (Nobel Biocare, Göteborg, Sweden). These studies had favorable results, suggesting acceptable implant survival and prosthesis stability rates.[6–9]

It has previously been shown that implants placed in posterior jaw regions have higher failure rates because occlusal forces are greater in that area and the available bone is usually of poorer quality.[5] New options for different anatomic situations have been developed to meet higher demands in the

Table 1 Distribution of Implant Lengths and Locations

	Implant length (mm)					
	7.0	8.5	10.0	11.5	13.0	Total
Maxilla						
Premolar	2	4	3	1	2	12
Molar	4	1	2	1	3	11
Mandible						
Premolar	3	1	4	0	2	10
Molar	11	3	12	4	15	45
Total	20	9	21	6	22	78

treatment of various clinical indications. To reduce the risk of posterior implant failure and increase the ability of these implants to tolerate occlusal forces, wider implants (ie, 5.0 mm wide) have been developed and used.

An alternative has been to place 2 standard implants (3.75 mm wide) at a single site to mimic the anatomy of the roots. However, accessibility for surgical and prosthodontic treatment can be more difficult in the posterior jaws. The space available between adjacent teeth for implant placement may be insufficient to place 2 implants; bone density is typically low and bone contour unfavorable. Furthermore, using a 2-implant solution may limit mesiodistal bending, but lateral forces are often the load-determining factor.[9]

A wide-diameter implant takes advantage of the greater width of the buccopalatal bone, thus increasing the amount of implant surface available for osseointegration. The greater the implant surface, the lower the per-unit pressure is at such an interface.[10] The bone-implant interface can be controlled by clinicians through their choice of implants, implant site, site preparation, and mode of implant placement.

In 1988 a 5.0-mm implant with a new self-tapping design and threads up to the marginal platform was developed. This concept was supposed to provide for the engagement of more dense cortical bone at the alveolar crest by eliminating countersinking.[11] In 1996 the Nobel Biocare Wide-Platform (WP) Mk II implant was introduced. This implant design was intended for use with soft bone and insufficient bone height, as an immediate replacement for a fractured or unsuccessful implant, or for immediate placement after extraction. The WP Mk II implant has a conical design with a coronal flange. The threads extend to the level of the flange, which results in a squeezing effect when the implant is placed, allowing cortical engagement and making initial stability possible even in soft bone. These implants were designed to address wider sites and higher occlusal forces.[11]

The aim of the present study was to investigate and evaluate retrospectively the treatment outcome of WP Mk II implants used in the posterior region and the clinical experience of patients treated at the Department of Oral and Maxillofacial Surgery, Gävle County Hospital, Gävle, Sweden.

MATERIALS AND METHODS

Patients

The sample comprised 52 patients treated between 1997 and 2000 with 78 WP implants in the posterior segments of the maxilla and mandible. Of a total of 58 consecutively treated patients, 6 subjects (10.3%) were not included—2 patients (2 implants) had moved away from Sweden, 2 patients (3 implants) refused to attend a follow-up examination, and 2 patients each had only 1 unloaded ("sleeping") implant. The remaining 52 patients (34 women and 18 men, mean age of 55 years, range 19 to 81 years) were examined retrospectively according to a study protocol. Implants were considered failures if pain, infection, paresthesia, implant mobility, or radiographic marginal bone loss to the apical third of the implant was found.[6]

Implants

Seventy-eight self-tapping WP Mk II implants with a marginal flange were used. All were 5 mm wide; they varied in length from 7.0 to 13.0 mm. Twenty-three were placed in the maxilla and 55 in the mandible. The implants had been integrated in the jawbone and functionally loaded for a period of 11 to 58 months at the time of clinical investigation. The mean follow-up time was 33 months. The lengths and locations of implants in the maxilla and the mandible are shown in Table 1.

Implant Treatment

All information about the implants, surgical procedures, and prosthetic treatment was collected from the patients' records. Before treatment, all patients had been examined by their general dentist or a prosthodontist and subsequently by the maxillofacial surgeon who performed the surgery. The main causes for missing teeth were endodontic complications, periodontitis, caries lesions, and tooth agenesis. Implant placement was performed by 3 maxillofacial surgeons.

A 2-stage surgical procedure was performed according to the manufacturer's recommendations. Bone quality and volume were assessed before first-stage surgery based on radiographic and clinical examinations. In 4 patients there was insufficient

bone volume. One of the patients had a sinus augmentation surgery carried out using Bio-Oss (Geistlich Biomaterials, Wolhusen, Switzerland) and autogenous bone. In 3 of the patients, exposed threads in the maxilla were covered with particulated bone and a resorbable membrane (Bio-Gide; Geistlich Biomaterials). Patients were given antibiotic prophylaxis, 2 g of phenoximethylpenicillin (Kåvepenin; Astra, Södertälje, Sweden), twice a day for 7 to 10 days immediately before surgery. In all patients initial implant stability was achieved. All the implants were submerged and the sutures in the mucoperiosteal flaps remained in place for 10 days. Second-stage surgery was performed after 3 months in the mandible and 6 months in the maxilla. Radiographs of the implants were taken after second-stage surgery to assure accurate abutment connection and to assess the marginal bone level and the status of bone-implant contact.

During the healing period and prosthetic treatment, most checkups were performed by the referring dentist. (All referring dentists had taken a course in implantology.) The patients were restored with various types of prostheses—1 implant-supported fixed complete prosthesis (2 implants), 32 single crowns, and 33 implant-supported fixed partial prostheses (44 implants) (Table 2). Either MirusCone abutments (Nobel Biocare) with screw retention of the prosthesis or CeraOne abutments (Nobel Biocare) with cementation of the prosthesis (either zinc-phosphate cement [DeTrey, Konstanz, Germany] or temporary cement [TempBond; Sybron Dental Specialties/Kerr, Orange, CA]) were used. The CeraOne and MirusCone abutments were tightened with a machine countertorque to 45 Ncm and 32 Ncm respectively. Of the 78 implants, 73 supported ceramometal restorations, 1 supported an In-Ceram crown (Vita, Bad Säckingen, Germany), and 4 supported gold–acrylic resin restorations.

Table 2 Distribution of Implants by Type of Prostheses Supported

	Implants	
Restoration	n	%
Single	32	41.0
Partial	44	56.4
Complete	2	2.6
Total	78	100.0

Examinations

Between September and November 2001, all treated patients were recalled for reexamination. A strict protocol was followed for the examinations, which were performed by 2 calibrated examiners. The parameters were the same for all patients: implant survival, marginal bone changes, and technical complications were assessed. Patients were asked if they had had pain, infections, or paresthesia in the peri-implant area. They were also asked about their general satisfaction with the implant-supported prosthesis and the overall outcome of the treatment. Notations were made of the number of implants and the positions, locations, and lengths of the implants.

The age and gender of the patients were registered. The date of first-stage surgery, the date of follow-up, the type of prosthesis, and the occlusal contacts in centric occlusion and lateral movements were registered. The appearance of the soft tissue surrounding each implant unit was evaluated as well as the presence or absence of bleeding and plaque formation. Using a periodontal probe with light pressure, a Sulcus Bleeding Index[12] was assessed on the mesial, distal, buccal, and lingual surfaces (0 = no bleeding; 1 = bleeding). The Plaque Index (0 = absence of plaque; 1 = presence of plaque) was measured on the same surfaces used for the Sulcus Bleeding Index.[12] If the restoration was freestanding, the stability of the supporting implant was checked. However, in the 44 patients with implant-supported fixed partial prostheses, verification of individual implant mobility, which would have necessitated prosthesis removal, was not possible.

General Health and Prosthodontic and Radiographic Examinations

General Health. In accordance with the study protocol, patients were asked questions about their general health, medications used, and use of tobacco. They were also asked whether they had received any radiation treatment.

Prosthodontic Examination. The prosthodontic results were recorded as successful at the final evaluation if the implant-supported restoration remained in place and there had been no technical complications such as veneer or framework fractures, loosening, or screw or prosthesis fracture.

Radiographic Examination. Radiographic examinations were performed for all 52 patients at the time of the clinical follow-up examination. Intraoral periapical radiographs were exposed using a long-cone paralleling technique. The radiographs were used to measure the distance from the reference point on the implant flange (the edge between the vertical and conical parts of the implant head) to the first implant-bone contact at the mesial and distal surfaces of each implant (Fig 1). The measurements were performed to the closest 0.1 mm. All radiographs were

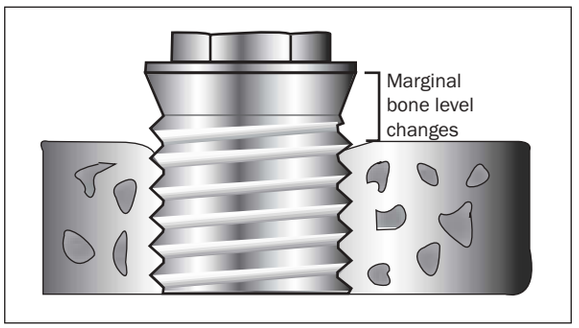

Fig 1 Schematic drawing of reference points used in the radiographic assessment.

Table 3 Life Table Analysis

Time period (y)	No. of surviving implants	No. of failed implants	Cumulative survival rate (%)
0–1*	78	7	91.0
1–2	76	1	89.8
2–3	66	0	89.8
3–4	48	0	89.8
4–5	18	—	—

*Period began at implant placement.

examined by the same radiologist with respect to density changes and bone architecture surrounding the implants. Marginal bone changes were calculated for each site at the time of observation.

Statistical Analysis

For general analysis of the study material, descriptive statistics were used. Survival analysis and a life table method were used to estimate the prognosis for the long-term survival rate of the implants. Implants 7 or 8.5 mm long were considered "short"; implants 10, 11.5, or 13 mm long were considered "long." A Mann-Whitney *U* test was performed to analyze differences between the 2 groups with respect to survival rate. All statistical analyses were performed using SPSS version 11.0 (Chicago, IL).

Ethical Considerations

The study protocol was approved by Committee of Ethics, Dalarnas forskningsråd, Falun, Sweden. All patients were informed of the present study in writing and through personal communication by phone. The information emphasized the purpose of the study, that the participation was entirely voluntary, and that they were free to withdraw from the study at any time and for any reason.

RESULTS

Of the 78 implants included in the present study, 8 were lost during the follow-up period, resulting in an overall survival rate of 89.8%. Better results were seen in the mandible compared to the maxilla. In the maxilla, 5 of 23 implants were lost (survival rate: 78.3%), and 3 of 55 implants were lost in the mandible (survival rate: 94.5%). All of the failed implants in the maxilla were in female patients. Those that failed in the mandible were in male patients. All failures occurred within 2 years of the first surgery (Table 3). These implants have now been replaced. Three implants were lost before prosthesis connection, and 5 were lost after 8 to 20 months of loading. Most failures involved shorter implants. The short group (n = 29) demonstrated significantly more failures than the long group (n = 49) ($P < .05$). Of the 8 lost implants, 4 (50%) were 7 mm long and 2 (25%) were 8.5 mm long. Of 11 patients with smoking habits, 2 experienced implant loss (18%), whereas of the 41 patients in the nonsmoking group, 3 (7.3%) experienced implant loss.

Soft tissue conditions around the implant-supported restorations were considered healthy in most of the patients. Plaque accumulation was found in 10% of the implant positions, and bleeding from the periimplant mucosa, which was managed by attention to oral hygiene, in approximately 15%. One technical complication appeared in 1 patient who had a small porcelain fracture in a ceramometal crown; only slight polishing of the rough surface was necessary to correct this. All patients were satisfied with the esthetic and functional outcome as well as the overall treatment.

Radiographic measurements and evaluation of marginal bone changes were performed in 70 functional implants at the time of the follow-up examination. The implants were documented using panoramic radiographs at second-stage surgery (baseline radiographs), but 28 of these radiographs were not acceptable for the evaluation of marginal bone change. Marginal bone loss, when noted, was recorded on the most recent periapical radiograph. The radiograph examinations revealed that the marginal bone changes generally were moderate (Table 4).

DISCUSSION

The variety of restorations available for posterior edentulous areas offer different treatment options for the patients, but it is not always necessary to replace missing teeth. Before deciding on what type of conventional removable or fixed prosthetic restoration to

use, the possible advantages and disadvantages of implant therapy, nonsurgical tooth replacement, or forgoing treatment altogether must be considered. In the posterior region, the indications for replacing a missing molar are usually functional and psychologic. When more teeth are lost, esthetics and masticatory efficiency may be added to the indications. Data on the survival of FPDs have been variable, if not controversial. Palmqvist and Swartz[13] described a 3% loss rate for FPDs within a period of 18 to 23 years, while Schwartz and colleagues[14] reported a failure rate of 20% in a 3-year study. Randow and associates[15] examined 316 FPDs made by 112 general practitioners in Malmö, Sweden. The results showed high rates of cariologic (18% to 31%), endodontic (5% to 23%), periodontal (7% to12%), esthetic (10% to 16%), and technical (8% to 34%) complications.

High success rates have been reported for endosseous implants in the rehabilitation of completely edentulous or partially edentulous jaws.[2,7,16] In the present study, the cumulative survival rate was 89.8% with 52 patients and 78 implants, an acceptable survival rate in the posterior jaw areas. The cumulative survival rate was higher than that previously reported in a retrospective study by Eckert and coworkers.[17] That study described the survival of 85 WP Mk II implants, placed in 63 patients, with a mean follow-up of 286 days. Implant loss was 19% in the mandible and 29% in the maxilla; no relationship was noted between implant survival and implant length. In the present study, implant loss was 5% in the mandible and 22% in the maxilla, and relationships were found between implant failure and implant length and between implant failure and maxillary bone. Bahat and Handelsman[18] reported a low failure rate (2.3%) for 59 Brånemark System wide-diameter implants that replaced molars. All failures occurred in mandibles after a mean loading period of 1 year. These authors concluded that the posterior mandible yielded more failures than the corresponding area of the maxilla. One suggested reason was that the implant is supported by only 1 cortical layer because of the presence of the inferior alveolar nerve. Bahat and Handelsman suggested changes in surgical technique when using 5-mm-wide implants. Polizzi and associates[5] reported a 95% survival rate after 1 year in a retrospective multicenter study based on 20 wide-diameter implants. In that study, implant loss occurred only in mandibles. Low vascularity of the mandibular marginal bone, absence of bicortical stabilization, and insufficient healing time were suggested as reasons for the failures. Aparicio and Orozco[19] retrospectively evaluated 94 wide-diameter implants. The cumulative success rate after 4 years was 97.2% in the maxilla and 83.4% in the mandible. In a retrospective report, Ivanoff and coworkers[20] found a relationship between implant failure and implant diameter, with a higher failure rate of 18% for the 5.0-mm-diameter implant. The cumulative survival rate was 73% after 5 years. A learning curve, poor bone quality, and changed implant design were suggested as possible reasons for the less positive outcome seen for the wide-diameter implants.

Table 4 Marginal Bone Changes (in mm) According to Either Radiographic Assessment at Follow-up (n = 70) or Baseline Radiographic Documentation (n = 42)

Marginal bone change	Mean	SD	Range
Calculated using baseline radiograph	–0.7	0.9	–2.8 to 1.3
Calculated using radiograph taken at follow-up examination	–0.9	1.0	–3.0 to 2.8

*Period began at implant placement.

However, in the present study the results are encouraging, considering the rather unfavorable situations (poor bone quality, poor bone volume, and placement in the molar area) in which the WP Mk II implants were placed. According to Polizzi and associates,[5] placement of wide implants in dense mandibular bone with low vascularity and remodeling capacity can be a risk. It may be advisable to use a bone graft or a guided bone regeneration technique, or a combination of both, with the placement of longer implants in the maxilla to increase the host bone volume.

All implant-supported restorations were immobile when tested clinically. The appropriate way to demonstrate implant immobility is to test all the unattached implants individually. In this study, 32 single crowns could easily be individually tested for implant stability. However, 44 implants were connected to fixed partial prostheses, either cemented or screw retained, and therefore were not individually checked. Current clinical methods used to assess implant stability and osseointegration are percussion and radiography. These are not reliable qualitative techniques. Resonance frequency analysis,[21] a noninvasive techique in which a small transducer is attached to an implant, gives responses in a reproducible and repeatable manner. However, this method was not used in this study.

Other than implant loss no severe complications were observed in the present study. Only 1 technical complication related to parafunctional forces was observed, a small porcelain veneer fracture in a single maxillary molar crown. Lekholm and coworkers[6]

have shown that this complication is quite common. The shortcomings in this retrospective study were that the patients were treated by their own general dentists. Data were collected from the surgical records, but it was not possible to get all the information concerning the prosthetic procedures. Although it is desirable that all patients be recalled once a year after the first year of the prosthesis function, this check-up was not done in a few cases.

CONCLUSION

Within the limits of this retrospective study, the results suggest that the use of WP Mk II implants in the posterior areas can be a predictable and safe procedure. Replacement of premolars and molars with implant-supported single crowns or FPDs was successful. Of 78 WP Mk II implants, 8 were lost in 7 patients. In 5 patients, the main cause was failure to establish or maintain osseointegration after functional loading, and in 2 patients osseointegration was lost before loading.

A fractured porcelain veneer in 1 single crown was easily repaired. The marginal bone resorption around the implants was moderate. The results of this study suggest that wide-diameter implants can be used in clinical situations where indicated. However, the results indicate that it is advisable to use wide implants longer than 8.5 mm in the posterior areas to minimize the risks for failure, as these regions present higher masticatory loadings, greater lateral forces, and sometimes, compromised bone quantity.

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