A descriptive 18-year retrospective review of subperiosteal implants for patients with severely atrophied edentulous mandibles

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Statement of problem. Fabricating dentures for the patient with severe mandibular atrophy can be a challenge for both the dentist and patient. Subperiosteal implants with a mandibular overdenture may be a solution for the atrophic mandible.

Purpose. The purpose of this retrospective study was to review the survival of mandibular subperiosteal implants placed at the University of Missouri Kansas City (UMKC) School of Dentistry Graduate Prosthodontics program between 1982 and 2000.

Material and methods. Forty subperiosteal implants were placed in atrophic mandibles of 40 patients (33 women, 7 men) between 1982 and 2000. The age range of the patients was 47 to 80 years of age at time of placement (mean = 62 years). Each patient was reviewed clinically by an author (DJM). Manual depression and lifting of the framework were used to evaluate the stability of the implant. Additionally, the implants were observed for any movement. Each patient was questioned for pain or discomfort. Each patient was examined for observable inflammation and intraoral exposure of the framework and questioned as to whether the implant had satisfied the patient and met the patient's expectations.

Results. Thirty-nine of the 40 original patients were recalled in 2000. One patient had died. Fourteen patients had implants for over 10 years, 12 patients had implants between 5 and 10 years, and 12 patients had implants for less than 5 years (mean time of implant service = 8 years). Thirty-eight patients had the implant in place with no sign of inflammation or mobility, 1 patient with diabetes had inflammation around one of the struts. All patients were wearing their prostheses, and there was no sign of exposed implant framework for any patient. All patients reported a high level of satisfaction with the implant.

Conclusions. Within the limitations of this study, the mandibular implants placed at UMKC were still functioning, and all patients denied any discomfort or pain from the prostheses. Patients reported they were comfortable and able to function with the implant-supported prosthesis. (J Prosthet Dent 2004;92:145-50.)

CLINICAL IMPLICATIONS

For the patients reviewed for this study, the prostheses supported by subperiosteal implants were still in function and pain-free. The subperiosteal implant is an alternative treatment to stabilize the mandibular denture for patients with a severely atrophic mandible.

For patients with a severely resorbed mandible, wearing a conventional denture may be difficult. The bony structure that supports the denture, as well as the musculature, such as the mentalis muscle, which was previously attached to the bone, may be lost. The denture may move constantly under function without a broad base of bone and the musculature to maintain the denture in place.

Dahl[1] placed the first subperiosteal implants in 1940. Criticism of his implant technique by the Swedish government caused him to abandon his efforts.[1] In 1947 the first American subperiosteal implants were developed.[2] In 1948 Gershkoff and Goldberg[2] placed the first subperiosteal complete denture implant manufactured of Vitallium.

Mandibular subperiosteal implants have been shown to be successful.[3] Linkow[3] reported removing 4 subperiosteal implants out of a patient base of 317 patients. Recall was not consistent, but Linkow[3] reported post-insertion care for 271 patients, and at least 110 of the patients were recalled between 1 and 2 years after surgery. Bodine and Yanase[4] reported a 5% failure of subperiosteal implants within 5 years after placement, 22% failure within 10 years, 34% failure within 20 years,

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and no failures after 20 years. Golec and Krauser[5] reported on the longevity of 241 hydroxyapatite (HA)–coated mandibular subperiosteal implants and recorded a loss of 5 implants, for a survival rate of 98% over a 7-year period. Yanase and Bodine[6] reported on subperiosteal implants placed at the University of Southern California Advanced Prosthodontic clinic. The authors reported a 79% survival rate of 10 years for 63 patients, a 60% survival rate for 15 years, and that the long-term survival rate of the subperiosteal implant was low.[6] James[7] reported a survival rate of 87% for implants placed in 26 patients over a 10-year period; however, 82% of the patients that began the study were lost to recall.

Previous subperiosteal frameworks were designed to rest directly on the alveolar crest.[1,3] In 1982, a new design was devised by the author of the present study after considering personal suggestions by Linkow and his laboratory technician. Linkow[3] refers to this design as the *tripodal mandibular subperiosteal implant*. The implant rests on the thick cortical bone present at the external oblique ridge and the symphysis of the mandible at the genial tubercles.[8] Bone relies upon muscle function and attachments to resist resorption.[3] The tripod design uses the mandibular symphysis and the angle of the mandible as locations for the framework to rest upon.[3] The area of the mandibular symphysis, where the genioglossus muscle and the geniohyoid muscle attach, forming the genial tubercle, is resistant to resorption over time.[3] The angle of the mandible is the attachment for the internal pterygoid muscle and the masseter muscle. Due to the functional attachments for these muscles, the angle resists resorption over time.[3] These 2 locations, the symphysis and the angle of the mandible, are better areas for the location of the feet or mesh of the subperiosteal implant.[3]

Mandibular subperiosteal implants have been placed at the University of Missouri Kansas City (UMKC) School of Dentistry since 1955.[9] In 1983, Young and Moore[10] reported the success rate of subperiosteal implants resting directly on the alveolar crest of 11 patients. One patient passed away, and 3 implants were removed, 1 each at 12 years, 8 years, and 2 years. Eight of the implants had been in place for 10 years, with 6 of them successful, resulting in a 75% success rate.

The purpose of this paper is to report on the longevity of 40 implants placed in 40 patients at the UMKC School of Dentistry over an 18-year period using a tripodal mandibular subperiosteal implant design. Design changes were initiated by the author to reflect current theories of placing the implant on dense cortical bone of the symphysis and angle of the mandible.

MATERIAL AND METHODS

This study included 40 patients who received mandibular subperiosteal implants at UMKC Graduate Division of the Department of Prosthodontics between 1982 and 2000. Informed consent was obtained from each patient; consent forms were given to each patient, the procedures were explained, and the risks and benefits of the procedure were explained to the patient's satisfaction. During this time period, 40 subperiosteal implants were placed. Patients received a dental exam upon referral from the predoctoral program after being identified as patients with complex dental needs. The dental exam consisted of a review of the medical history, an oral cancer examination to include palpation of the neck and soft tissues, and the making of a panoramic radiograph. The panoramic radiographs were not standardized. A TMJ evaluation was completed to observe the patient's ability to open and close and move laterally without discomfort, popping, or clicking. A visual exam was completed of the gingival tissues to ensure that no inflammation or oral lesions were present. Complete dentures were made for each patient, and an adjustment period of 6 weeks was allowed for each patient to determine if the patient still wanted to pursue the placement of an implant. Patients then reviewed the possibility of having the mandible and denture fitted with a subperiosteal implant. The 40 patients requesting implant therapy were reevaluated for a change in medical history and approved additionally by the UMKC School of Dentistry, Department of Oral Surgery. The surgical management was directed by 1 oral surgeon assisted by oral and maxillofacial surgery residents. The exclusion criteria for implant placement included a history of smoking, diabetes, autoimmune disease, a heart valve replacement, or osteoporosis. All patients selected were in optimal health.

Thirty-eight of the patients were treated with the same surgical/prosthodontic technique of bone exposure and impression. Over the first 5 years some slight modifications of framework extensions developed. Framework design was based on the work by Linkow[3] and required 3 points of support for the framework. The framework used the anterior or medial surface of the rami as the bilateral posterior supports for the bar and the mandibular symphysis, between the mental foramina, for the anterior support. Four posts were designed into the casting to exit the tissue. Two posts were posteriorly located and overlaid the dense bone of the ramus. The anterior bar was located over the symphysis area and the 2 remaining posts were located anterior to the area of the mental foramen. The posts each had a cast ball at the end for the placement of attachments (O-ring; Attachments International, San Mateo, Calif). All frameworks were fabricated out of a surgical-grade chrome-cobalt alloy (Vitallium, 60% Cobalt, 30% Chromium, and 10% Molybdenum; Dentsply Austenal, York, Pa) All castings were completed by a single lab. During the last year of the study, 2 of the frameworks were developed using computerized

tomography (CT) scans and stereolithography.[11] The 2 frameworks, fabricated using the CT scan, were completed by the same dental lab, but only required 1 surgery.

The initial surgery for the first 38 implants was performed using local anesthesia only or with the aid of intravenous sedation. An incision was made on the alveolar crest, and the tissue reflected to allow an impression to be made directly over the bone to include the angle of the mandible and the external oblique ridge on the labial aspect. The facial and lingual extensions of the symphysis of the mandible anteriorly were impressed. Impression material (Permalastic; Kerr, Orange, Calif) was used in a custom impression tray. Interocclusal records using autopolymerizing resin were made (Duralay Inlay Resin; Reliance Mfg Co, Worth, Ill). A local dental laboratory was used that allowed overnight fabrication of the implant.

The patient's mandible was closed using silk sutures, and the patient was instructed to return in 24 hours for placement of the framework. All 40 of the frameworks went into place initially and none was remade. The fit of each implant was evaluated subjectively at the time of the second surgery by observing the contact between the implant framework and the underlying bone. The denture occlusion was evaluated by means of a clinical remount procedure, but only the maxillary denture returned to the patient. The mandibular overdenture was placed following resolution of any inflammation associated with the surgery, typically, within the first 2 weeks. The mandibular denture was lined with a resilient liner (Lynal; Dentsply Caulk, York, Pa) and retentive components (O-ring; Attachments International) were placed directly into the denture. The denture was then inserted using remount procedures to refine the occlusion.

The patients were recalled weekly for the first month, then monthly for 6 months and recalled every 6 months or annually depending on the patient's ability to maintain acceptable oral hygiene for the prostheses and the soft tissues surrounding the post interface and bar structure. Attachments were replaced after 1 month and as needed for patient comfort during the recall visits. The patient was not charged for recall appointments and attachment changes until 2002 to encourage patient participation.

Each patient was evaluated objectively by examination of the patient and a review of the patient's treatment record. Each patient was examined to ensure that the implant was in place and functioning normally. Mobility of the implant was evaluated by manually pressing on the implant in lateral, superior, and inferior movements. Any movement of the implant was then recorded. Radiographs, although not standardized, were compared to the original in a subjective manner to identify bone loss under any abutment, or major strut, and to determine any change in the position of the framework. Changes were evaluated by observing the degree of the strut lying on the bone or any loss of bone resulting in movement of the strut below the superior border of the bone. Gingival health was evaluated by observing the degree of inflammation.

Table I. Questionnaire for subjective evaluation

1. Is there now or has there ever been any discomfort?
2. Is function adequate with the implant?
3. Are you restricted to a soft diet?
4. Can a normal diet be consumed without special preparation?
5. Have you experienced any infection around the implant?
6. Is the denture retentive and stable?
7. Is the denture adapted to the soft tissues to prevent debris impaction?
8. Are you satisfied with the implant?
9. Could anything further be done to enhance satisfaction?
10. Would you have the procedure done again if you could?

All patients reported for the follow-up study and were evaluated by the prosthodontist who initiated the treatment for all patients. If any resorption occurred, the framework of the implant would be seen inferior to the border of the mandible. The new radiographs were compared to the original panoramic radiographs to note any possible changes. Each implant was evaluated for comfort to the patient, inflammation present around the abutments, mobility, and framework failure.

The authors used a grading system to evaluate the degree of inflammation. Patients with no inflammation present were assigned a grade of 1, those with mild inflammation, which is determined by a slight color change and edema, were assigned a grade of 2. A grade of 3 was assigned to patients with redness of the tissues, edema, and glazing. Patients were given a grade of 4 if severe inflammation was present with marked redness, edema, and ulcerated tissue around the framework.

The subjective criteria for success included adequate function, absence of discomfort, improved esthetics, and improved emotional and psychological attitude. A questionnaire (Table I) was completed by each participating patient to evaluate the subjective criteria at the time of the year 2000 evaluation. Answers to the questions were yes and no, but the patient had the opportunity to add subjective answers if they desired. The questionnaire was provided to the patients by the authors.

RESULTS

Thirty-nine surviving patients were able to be recalled for the study, and all returned with the implant in place and in service. One patient had passed away following a heart attack. One patient had developed diabetes that, while under control, resulted in some tissue inflammation.

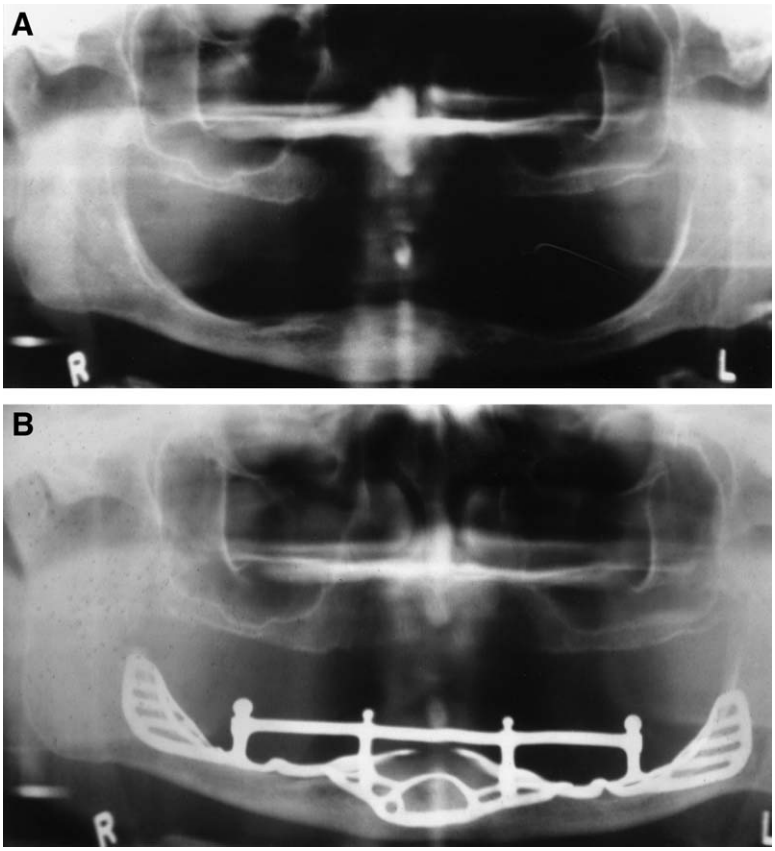

Fig. 1. Panoramic radiograph of a study participant. **A,** Prior to implant placement. **B,** After implant placement.

The UMKC graduate prosthodontic faculty and students supported the subperiosteal implant patients by changing O-rings and performing maintenance for the patients at no charge following the time of implant placement. This allowed the records to be kept up-to-date for most patients, as patients often returned for the free maintenance care. There was no limit to the number of free visits the patients could make. The dentures were cleaned and the bars polished. With the exception of the diabetic patient, 38 patients evaluated displayed no inflammation. The diabetic patient displayed Grade 2 inflammation.

Several of the dentures were remade for the patients at a nominal cost as the denture teeth wore or the maxillary denture became loose. However, no information as to the number of dentures that were remade was available to the authors. Occlusal wear was a major concern for several of the patients. The ability to masticate harder and more fibrous foods caused increased wear of the occlusal surfaces. In one situation, the dentures had to be remade after 2 years for a heavily-muscled male patient. Loss of vertical dimension of occlusion due to wear of the denture was noted in patients over the years, and dentures were also remade for this reason.

The age range of the patients at the time of placement was between 47 and 79 years, with a mean of 62.6 years. Thirty-three patients were women and 7 were men. The average age of the women at time of placement was 62.2 years, and the average age of the men at placement was 65.4 years. At the last clinical evaluation in the year 2000, the average age of the women was 70 years, with a range of 51 to 91 years, and the average age of the men was 72 years, with a range of 58 to 86 years. The frameworks were in place for a time period ranging from 2 to 18 years, with a mean of 8 years. The continuum of patient care has now concluded with 14 patients for over 10 years, 12 patients for between 5 and 10 years, and 11 patients for less than 5 years of implant service.

Only 1 patient, who developed diabetes after the implant placement, developed inflammation around the abutments. None of the 39 implants displayed mobility. None of the radiographs reviewed displayed bone loss under an abutment or major strut (Fig. 1). No implant was found to have moved inferiorly below the superior border of the bone. Gingival health was excellent for all 39 patients.

Thirty-nine patients reported satisfaction with the implant and functional ability. None were restricted to a soft diet, and all consumed a normal diet without special preparation. None of the surviving patients presented with infection around a strut. All patients believed the denture to be stable on the implant and

reported satisfaction with the implants. Three patients complained of food getting under the denture, but the food was easily removed after eating. Two patient suggestions for improvement were to eliminate any pain following the surgical placement of the implants. All 39 patients stated they would have the procedure done again.

DISCUSSION

Because this was a retrospective study, radiographs were not standardized at the time of implant placement. All analysis of bone volume and resorption was subjective. If a part of the implant moved or settled inferiorly with bone resorption, this would have been reflected in the denture occlusion, by allowing 1 part of the denture to occlude more heavily in the nonresorbed areas. The authors did not observe this type of occlusal change in any of the implants. Implant mobility was also a subjective observation by the authors. Although no movement of the implants was observed, no qualitative measurements were completed.

It is the authors' opinion that the success of the subperiosteal implants for the patients in this study was a result of the design. As all participating patients were healthy, there were no negative health factors to adversely impact implant success. Only 1 patient developed a health problem, diabetes. The only implant to show inflammation around the implant strut was present in the diabetic patient. The fact that the implants rested on areas of low bone resorption (basal bone), where muscle function helped preserve the volume and contours of the bone, may also have contributed to the success rate. The stability of the implants was noted by both patients and authors. Failure of many subperiosteal implants described in the literature resulted from continued bone resorption where the implant rested on the boney surface of the alveolus.[3] An advantage of the UMKC patients was the ability to fabricate the prosthesis within 1 day of the initial surgical procedure, as a local lab was able to provide a framework 24 hours after impression making. The short time frame may have resulted in less trauma to the tissues and bone from multiple surgical procedures.

In the future, the use of computed tomography (CT) may be an additional adjunct in developing the implant prior to any surgical intervention.[11] This procedure allows more flexibility in timing the laboratory phase prior to placing the subperiosteal framework. The CT technique was utilized for 2 of the last 5 implants placed in this study. It is the authors' subjective opinion that the fit of the implant frameworks indirectly fabricated by CT was adequate but lacked the retention of the implant frameworks made with the impression technique.

Recall of the study patients in 10 and 20 years may provide increased knowledge of problems that might occur. Individually and as a group, the patients were satisfied with the implants. The patients collectively experienced no pain and rarely had discomfort from the superstructure.

A limitation of the study was that the questionnaire was administered to the patients by the authors, which may have biased the results. Although the authors believe that endosseous implants are the treatment of choice for patients with adequate bone, the use of subperiosteal implants for patients with inadequate bone volume for endosseous implants may be a viable treatment option.

CONCLUSIONS

All subperiosteal mandibular implants placed at UMKC from 1982 to 2000 were reevaluated from 4 objective and subjective standpoints, a successful prosthesis was placed on the implant, no mobility of the framework was noted at time of examination, no bony changes were noted by the authors at follow-up examinations, the implant had no inflammation or exposure of the framework, and was deemed acceptable, pain-free, and comfortable to the patient. It was concluded that: (1) periodic recall is an important part of an implant program, (2) all of the subperiosteal implants reviewed were successful in that they were all restored with a prosthesis, had remained in place and pain-free for the evaluated time since placement of the implant, and (3) all patients reported satisfaction with the implants and implant-supported prostheses on a questionnaire supplied by the authors.

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Noteworthy Abstracts of the Current Literature

Clinical evaluation of short, machined-surface implants followed for 12 to 92 months
Tawil G, Younan R. *Int J Oral Maxillofac Implants* 2003;18:894-901.

Purpose. Bone resorption following tooth loss often limits the quantity of bone available for implant placement. The purpose of the present study was to evaluate the clinical outcome of 10-mm or shorter machined-surface implants when used exclusively in the treatment of various forms of edentulism.
Materials and Methods. Two hundred sixty-nine screw-type Brånemark System implants (Nobel Biocare), 10 mm or shorter, were placed in 111 consecutively treated patients. Of the total, 88.8% were placed in the mandible and 11.2% were placed in the maxilla; 95.2% were used to treat partially edentulous situations, including single-tooth losses, of which 96.6% were in the premolar and molar regions. The patients were followed for periods of 12 to 92 months.
Results. Of the 269 placed implants, 12 were lost. The overall survival rate was 95.5%. Bone quality 2 and 3 (Lekholm-Zarb classification of 1985) was found in 88.8% of the treated sites. There was no statistical difference in the survival rate of the 10-mm implants when compared to the shorter series ($P > .05$) or between the various implant diameters. The mean marginal bone loss was 0.71 ± 0.65 mm.
Discussion. The failure rate of 4.5% compares favorably with that of implants of different shape, surface characteristics, and length. Bone quality appeared to be the critical factor in implant survival, rather than bone quantity, in this patient series.
Conclusions. This study supports the survival of short, machined-surface implants when used for the treatment of partial edentulism in bone of good quality.—*Reprinted with permission of Quintessence Publishing.*