A 13- to 32-Year Retrospective Study of Bone Stability for Machined Dental Implants

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The goal of this retrospective investigation was to provide evidence of the longevity of machine-surfaced implants placed in native bone and treated with the original two-stage surgical protocol. The observation times of this study covered periods of 13 to 32 years. Consecutive cases were impossible; the patients’ ages when treated reduced the number of available people as a result of death, relocation, being impossible to find, or refusal to cooperate. Mean marginal bone loss after 13 to 32 years was 1.9 ± 0.9 mm, survival rate was 97.7%, and success rate was 92.7%. Peri-implantitis occurred in a limited number of cases, with a prevalence of 1.8%. This study demonstrates long-term reliability of machined implants as a therapeutic choice. Int J Periodontics Restorative Dent 2018;38:489–493. doi: 10.11607/prd.3694

The marginal bone loss (MBL) around dental implants identified as peri-implantitis has become recognized as a threat to their success. There is a lack of available data regarding long-term outcomes of dental implants in function for > 10 years, and additional studies are required to demonstrate longevity and to influence patient confidence in deciding on implants for tooth replacement.

As marginal bone maintenance has been identified as the primary factor for success, studies must address this factor. Early studies were complimentary to implant success.1 They were assessed relative to the criteria described by Albrektsson,2,3 by which a limit of 1.5 mm of bone loss in the first year and < 0.2 mm each year thereafter indicate success.2,3 The contemporary literature has focused more heavily on the time of implant treatment, including placement and loading; controlling the number of visits for patients; and esthetics, all of which are of great importance and interest but are challenged by increasing recognition of peri-implantitis.

The purpose of this study was to demonstrate the long-term success, over 13 to 32 years, of dental implants. It is intended to provide confidence to the dentist and to the patient in the likelihood of success offered by implant dental rehabilitation.
Materials and Methods

All patients received machined-surface implants between 1985 and 2001 from three different surgeons. The implants were placed in partially or totally edentulous ridges. The earlier placements were performed in two-stage surgical applications, as proposed by Brånemark, and the latter procedures were frequently done in one stage with healing abutments. Some cases were treated with simultaneous extraction of one or more teeth. No cases with significant native bone augmentation were included.

All patients were draped and the surgical team gowned to provide appropriate sterility. Early cases were confined to hospitals, but eventually the transition was made to office treatment.

All results were established from periapical and occasional panoramic radiographs and clinical examinations. Radiographs were not standardized. All images have been digitized in JPG format. Measurements of MBL were conducted using ImageJ software (National Institutes of Health) by an independent individual not involved with the treatment of the patients. Every image was corrected for distortion. Implant length and the distance between implant threads were used as a calculation standard.

The radiographic evaluation included the mesial and distal aspects of the implant shoulder with the mean value considered the MBL. The T₁ radiograph followed loading and the final (T₂) radiograph was taken at the follow-up between 2014 and 2017.

A total of 105 patients, 43 men and 62 women with a mean age of 45.2 years, ranging from 18 to 72 years, received 382 implants in the maxilla or mandible. Included patients had no local or systemic diseases that would contraindicate treatment. Active periodontal disease was resolved, and the majority of patients continued to participate in their professional maintenance program.

The implant provided in the study was the original Brånemark machined-surface with a screw-shaped fixture and an external hexagon prosthetic connection. They were manufactured from commercially pure titanium. The patients were robed, the staff gowned, and the operating materials sterilized following recommendations.

The Brånemark implants were placed according to the manufacturer’s direction. In the early years, two-stage surgeries were performed, but the later cases frequently had healing abutments placed with a single surgery. Later cases included immediate implants when the treatment plan was established. Mandibular implants were loaded after 3 months and maxillary after 6 months.

Results

This study presents the results of implant treatment for 105 patients who received 382 implants. It was impossible to include consecutive patients, as many died, relocated, or were not compliant. Of the included patients, 10 patients were smokers at the time of the first visit and remained smokers during the follow-up period. All had radiograph records from the time of placement and restoration and were available for 13 to 32 years, with a mean of 20.7 years. Most were observed at some time between 2014 and 2017, if they were still alive.

The cumulative survival rate was 97.7%, with a success rate of 92.7%. Nine implants failed, and seven implants suffered significant peri-implantitis. Mean MBL was 1.9 ± 0.9 mm (Fig 1).

Implants still in function were considered surviving. An implant was considered successful if it met the success criteria proposed by Albrektsson and Zarb,² by which a limit of 1.5 mm of bone loss occurred in the first year and < 0.2 mm occurred each year thereafter.²

The data was recorded in Microsoft Excel and checked for entry errors. Descriptive statistical analysis included mean and SD for continuous variables, with proportions calculated for categorized variables.

Eight implants failed to integrate, four in the maxilla and four in the mandible, and one was lost to function after 6 years. The cumulative survival rate was 97.7%, and the success rate was 92.7%.

Mean bone level at T₁ was 1.5 ± 0.6 mm below the implant shoulder and at T₂, 1.9 ± 0.9 mm. The differences observed in MBL were 2 mm (SD 0.9 mm) in the maxilla and 1.8 mm (SD 0.7 mm) in the mandible (Table 1).

Stable MBLs were found in 339 of the 382 implants with MBL < 3 mm at the last examination (Fig 2). Marginal bone resorption > 3 mm was found in 34 implants (9.1%). Only 3 patients with a total of
7 implants (1.8%) were affected by peri-implantitis, defined by crater-like bone defects with bleeding on probing, suppuration, and increased probing depth as defined by Albrektsson et al. All 3 patients were smokers, and implants were in function for 16 to 18 years and classified as survivals. No implants were restored with platform switching.

**Discussion**

There has been an increased interest in implant complications in the new millennium, as evidenced by the number of publications related to peri-implantitis and the percentage of lecture time dedicated to this topic at continuing education programs. A minimal MBL of 1.5 mm has been accepted as a result of the microgap at the implant and the abutment junction during the first year of loading, and the postulation of the conjunction of success was that it should not exceed 0.2 mm/year.2,5 The purpose of this study was to evaluate survival and success rates, MBL, and the occurrence of peri-implantitis with machined-surface implants placed in native bone after a follow-up of 13 to 32 years (Fig 3). The rehabilitation of locally and completely edentulous ridges using osseointegrated implants is a proven therapeutic procedure. It has been estimated that about 12 million dental implants are placed every year, with a high survival rate.6 The use of dental implants continues to increase, with the advantages of three-dimensional radiographs for diagnoses, navigation systems to provide optimal positions for prosthetic restoration, and procedures for enhancement of bone volume to place implants. This manuscript details the fate of implants placed before these advantages and only in locally or totally edentulous ridge using the original protocol, with machined implants placed with two surgical procedures in most cases.

The present study showed a high rate of implant survival after 13 to 32 years (97.7%). This result is in accordance with other long-term studies on machined implants.
Ekelund et al reported a survival rate of 98.9% after 20 years, Bergen-block et al reported a cumulative survival rate of 96.8% at 18 years, and Dierens et al reported a cumulative survival rate of 91.5% after 16 to 22 years.

The mean MBL of 1.9 ± 0.9 mm below the implant shoulder after 13 to 32 years of observation demonstrates high stability around this type of implant (Fig 4). This result is in accordance with Dierens et al; Astrand et al observed only limited bone loss after 20 years, with the bone level at the time the final survey was established to 2.33 ± 0.13 mm below the reference point. A mean MBL of 0.78 ± 0.88 mm was found by Simion et al in a perspective study with a follow-up of 12 years considering 29 patients treated with 59 machined implants placed in the posterior maxilla with reduced bone height (Fig 5).

The routine parameter used to evaluate the health of implants has been loss of marginal bone. The implants studied were placed between 1985 and 2000. The data from this study demonstrated very low prevalence of implants affected by peri-implantitis (1.8%) and an extremely slow progression of marginal bone loss around the affected implants (Fig 6).

One could ponder the explanations, but during the study period there were fewer manufacturers and most were delivered by individuals with significant surgical backgrounds. In many cases, a space was found for the patient to debride between the prosthetics and mucosa.

Other factors associated with early MBL are surgical trauma, prosthetic loading, excess of cement while delivering the restoration, biologic seal, and genetic susceptibilities. Those associated with late MBL include patient susceptibility to inflammation and smoking. History of previous periodontal disease is questionable, because it has been demonstrated not to be a problem when the disease has been eliminated and a strict maintenance program is followed.

Fig 4 (a) Clinical view of a prosthetic rehabilitation of the maxillary left premolars, delivered in 1988. (b) Periapical radiograph of the same sites in 1988. (c) After 29 years of function, mild marginal inflammation is present at the second premolar. (d) Periapical radiograph after 29 years demonstrating no marginal bone loss.

Fig 5 (a) Completely edentulous patient treated with a full-arch implant rehabilitation. A lack of keratinized mucosa is evident in all the implant sites. (b) Panoramic radiograph showing absence of bone loss around the implants after 24 years of follow-up.
Improvements continue to protect against the loss of cervical bone. Platform switching, in which the abutment surface is smaller than the platform surface of the implant, seems to direct inflammation horizontally rather than vertically and has become readily accepted, but it is not a perfect solution. The rim of a laser finish on the implant and/or abutment demonstrates a physical attachment of the collagen fibers to the implant surface perpendicular to the implant, preventing apical migration of epithelium and demonstrating maintenance of cervical bone. The recent availability of hybrid implants may present another solution.

In an era when implant treatment is regarded as successful but peri-implant diseases appear to be increasing, studies with a follow-up of 20 years or more are obviously imperative. Implant longevity will increase the patient benefit and encourage the recommendation of implants.

Conclusions

This retrospective study of 382 machined Bränemark implants placed in 105 patients demonstrated 92.7% success and 97.7% survival. The implants were placed in localized edentulous ridges or into extraction sites. All judgments focused on marginal bone levels at the most recent patient examination. The implants were in place from 13 to 32 years, demonstrating small incidence of peri-implantitis and other complications. However, machined implants were used, placed with a two-stage surgical approach. The authors hope to use this information to influence potential patients as to acceptance of the possibility of longevity for implant therapeutics.

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References
