Clinical and radiographic evaluation of tapered implants with an aggressive reverse buttress thread and crestal microthreads: a retrospective study

Mayuri Kerr, BDS, MS;[*] Brett Allen, MS;[^] Neil Park, DMD[#]

Abstract

Recently, a new implant system which combines several features that promote osseointegration, including an aggressive reverse buttress thread that helps in establishing primary stability, crestal microthreads, a platform-shifted abutment connection, and a roughened implant surface treated with resorbable blast media (RBM), was introduced. The purpose of this two-year retrospective study is to evaluate the success rate, status of surviving implants, and mean bone loss (MBL) measures.

Materials and methods: 259 Hahn™ Tapered Implants placed by six dentists were included in the study to assess success of the system. Radiographic follow-up was available for 102 of the implants and these were used to measure crestal bone maintenance over time. Only restored implants were used in the crestal bone loss measurements.

Results: There were two implant failures out of the 259 implants placed, giving a success rate of 99.2 percent. Mean bone loss over two years was 0.20 ± 0.02 mm. A total of 102 implants were radiographically assessed and, of those, 33 implants (32 percent) had bone above the implant shoulder, indicating maintenance or growth of bone over time.

Conclusions: The Hahn Tapered Implant System is a reliable implant system with a high success rate and good maintenance of crestal bone.

*Clinical Affairs Manager, Glidewell Dental; Newport Beach, California
^Digital Dentistry Intern, Clinical Affairs, Glidewell Dental; Newport Beach, California
#Vice President, Clinical Affairs, Glidewell Dental; Newport Beach, California

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Introduction

The Hahn™ Tapered Implant System (Glidewell Direct; Irvine, Calif.) was first introduced in 2015. This system combines multiple features that promote osseointegration and long-term success. These features include an aggressive reverse buttress thread design that helps in establishing primary stability, crestal microthreads, a platform-shifted abutment connection, and an implant surface that has been roughened using resorbable blast media (RBM).

The Hahn Tapered Implant has a 1 mm machined collar and microthreads at its neck that help keep crestal bone surrounding the implant healthy. A microthread design in the implant neck can significantly reduce the amount of marginal bone loss under functional loading.[1,2] A platform-shifted connection ensures robust bone growth.[3] The use of resorbable blast media (RBM) as a surface treatment has been shown to maximize bone-implant contact and promote osseointegration.[4]

Implant success is generally determined by successful osseointegration, while implant survival is determined by an asymptomatic implant with adequate bone support. One method to gauge osseointegration is to measure crestal bone loss around an implant over time. Crestal bone loss is measured from the shoulder of the implant to the first bone-implant contact on the mesial and distal sides of the implant on a periapical or bitewing radiograph. The mean of these two measurements is called the mean bone loss (MBL). In a study outlining implant success criteria, Albrektsson et al. proposed that asymptomatic implants with 1 mm of MBL after the first year of placement were considered acceptable; subsequently, 0.2 mm of MBL per year is expected.[5]

The success of implant systems is also determined by calculating their survival in the long term. Modern implant systems are designed to osseointegrate well and produce high success rates around 93–96 percent. Schwartz et al. found in a 12-year retrospective study of titanium implants that total mean bone loss was 0.86 ± 1.8 mm, with a survival rate of 93.2 percent.[6] Similarly, a review by Moraschini et al. found that dental implants placed over a 10-year follow-up period had a survival rate of 94.6 percent and 1.3 ± 0.84 mm of MBL.[7]

Tapered implants, introduced in 1997, have had excellent results in the clinical setting. Ormianer and Palti found, over a mean follow-up period of 7.5 years, that the implant survival for tapered implants was 98.5 percent, with no discernable bone loss for 88 percent of surviving implants.[8] Arnhart et al. also found favorable results, determining that variable-thread implants had a 96.3 percent survival rate and low MBL of 0.16 ± 1.06 mm during a three-year study.[9]

The purpose of this paper is to present the findings of a two-year retrospective study on Hahn Tapered Implants. This study evaluates multiple parameters, including the success rate, status of surviving implants, and MBL measurements. These results will provide knowledge on the clinical behavior of the Hahn Tapered Implant System.

Materials and Methods

This retrospective study assessed implants for a period of two years after placement. A total of 259 implants of varying lengths and diameters were placed in 101 patients (53 males, 48 females) between April 2015 and April 2018 by six dentists. Data analysis was conducted during May 2018 by Brett Allen and Dr. Mayuri Kerr.

All 101 patients were included in the study. This included patients with histories of smoking, diabetes, and hypertension. Only restored implants with at least one annual follow-up radiograph were included in the crestal bone loss measurements. All implants were included in the survival analysis, as any failures were consistently reported to the operatories.

Treatment Prodedure

The treatment procedure included multiple appointments with each patient's respective dentist. These included diagnostic appointments, surgical appointments for implant

placement, and prosthetic appointments for placement of temporary and final restorations. When necessary, a bone graft was placed and the site was given four to six months for healing prior to implant placement. In other cases, bone grafts and implants were placed in the same appointment. Patients agreed to attend annual follow-up appointments where periapical and bitewing digital radiographs were taken to assess the health of the implant.

Measurement of Bone Loss

Bone loss was measured for the implants in cases where radiographs were available, as this allowed for comparison of MBL over a period of years. Radiographs were taken using a Nomad Pro™ handheld X-ray system (Aribex, Inc.; Charlotte, N.C.) set at 60 kVp and 2.5 mA. Radiographs were included in the study if the long axis of the implant was parallel to the plane of the sensor. If the image of the implant was tilted and had overlapping threads, making it difficult to assess bone loss, radiographs for that implant from that year were excluded from the study.

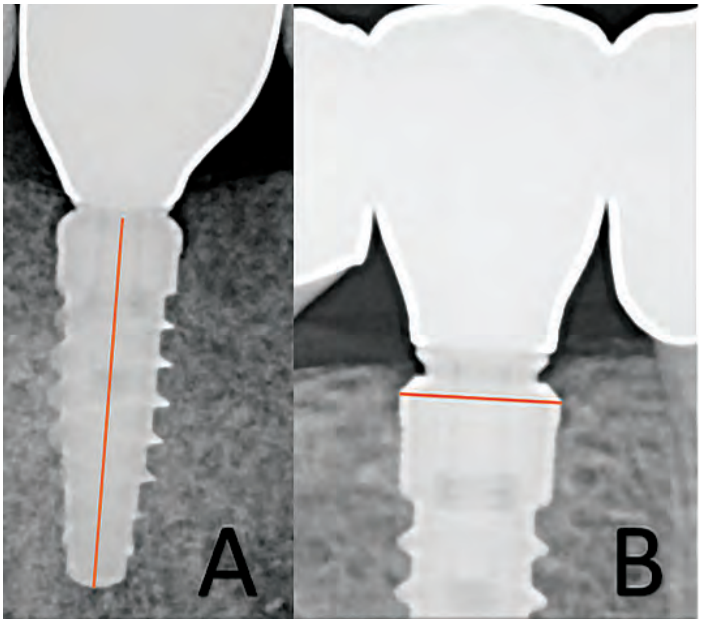
Radiographs taken between the established follow-up increments were rounded to the closest time period reported. For example, a 10-month radiograph was rounded to one year for follow-up measurements. Using ImageJ software version ImageJ 1.51j8 (National Institutes of Health; Bethesda, Md.), radiographs were calibrated individually by measuring the total length of the implant; in radiographs where the apex of the implant was not visible, the diameter of the implant was used for calibration *(Figs. 1a, 1b)*. Bone loss was then measured as the distance from the implant shoulder to the first contact of bone to implant. Bone loss was measured on both distal and mesial sides and then averaged to calculate MBL *(Fig. 2)*. Some patients did not have radiographs for each year of participation, but to be part of the crestal bone assessment, they had to have at least one radiograph at one-, two- or three-year follow-up.

Success and Survival

Any implant that was removed from its site of implantation due to unfavorable outcomes was considered a failure. All other asymptomatic implants that remained in the mouth were considered successful. Surviving implants with radiographs were spilt into three groups, by year, based on the amount of bone loss: MBL up to 0.5 mm, MBL up to 1 mm, and MBL greater than 1 mm.

Statistical Analysis

Analyses were performed for this study using Microsoft Excel version 16 (Microsoft Corporation; Redmond, Wash.) and the R version 3.4.4. "survival" package (R Core Team 2018).[10] To calculate the overall average bone loss, it was important to control for the bias introduced by multiple implants placed in the same patient. For patients with more than one implant, the first implant placed chronologically was included in statistical analyses. If multiple implants were placed on the same date, one implant was selected by using a random number generator. A Kaplan-Meier analysis was conducted to determine the cumulative survival of implants placed over the course of two years.



Figures 1a, 1b: *Radiograph A shows calibration of an implant by measuring the length of the implant using ImageJ software. In radiograph B, the diameter is measured because the implant apex is not visible.*

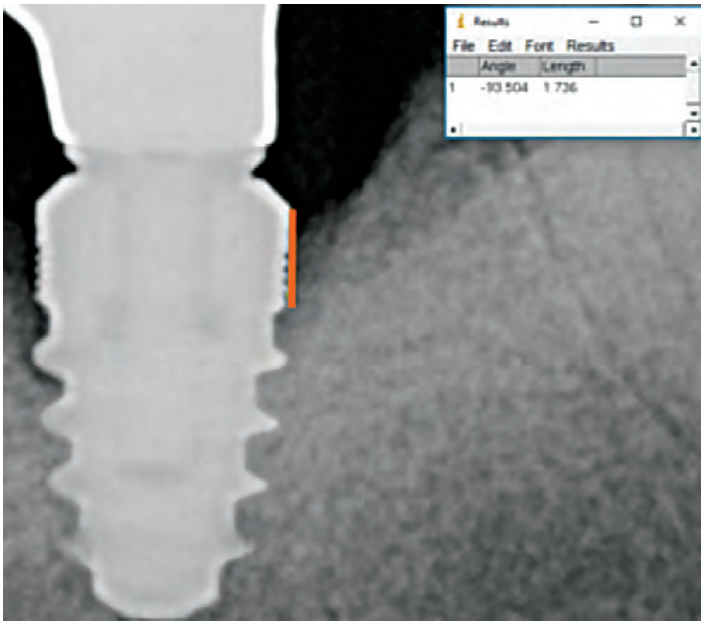


Figure 2: *The deepest point of bone loss was measured on both the distal and mesial surfaces of each implant.*

Results

Of 257 initially placed implants, two experienced early failure and were removed within four months of placement. The failed implants were replaced, and the new implants were included in the study. This brought the study total to 259 implants. There were no failures reported for the replacement implants. The success rate of implants placed in this study was 99.2 percent. The table below displays the types of final restorations that were attached to the implants *(Table 1)*.

Of the 259 implants, 102 (placed in 26 male patients and 25 females) had radiographic follow-up from one to three years *(Table 2)*. All implants included in the radiographic study had screw-retained restorations.

Of the 102 implants, some were lost to follow-up over time *(Table 3)*.

The figures below illustrate the arch distribution of the implants included in long-term follow-up *(Table 4)*, patient health data *(Table 5)*, and total implants placed categorized by length and width *(Fig. 3)*.

Restoration	No. of Restorations
Single Crown	96
Short-Span Bridge (up to 5 units)	4
Full Arch	8

Table 1: *Types of restorations placed on implants during the study.*

Year	Number of Implants with Radiographs
1	73
2	62
3	7

Table 2: *Total number of implants with radiographic follow-up per year of the retrospective study.*

Years After Placement	No Follow-Up
1	5
2	0

Table 3: *Patients lost to follow-up after implants were placed.*

Arch Distribution	Number of Implants Placed	Totals
Maxilla; anterior	23	54
Maxilla; posterior	31	
Mandible; anterior	8	48
Mandible; posterior	40	

Table 4: *Distribution of implants placed in each arch.*

Health Measure	Implants Affected
Smoking	13 (13%)
High Blood Pressure	14 (14%)
Diabetes	3 (3%)

Table 5: *Health data available for implant patients included in the study.*

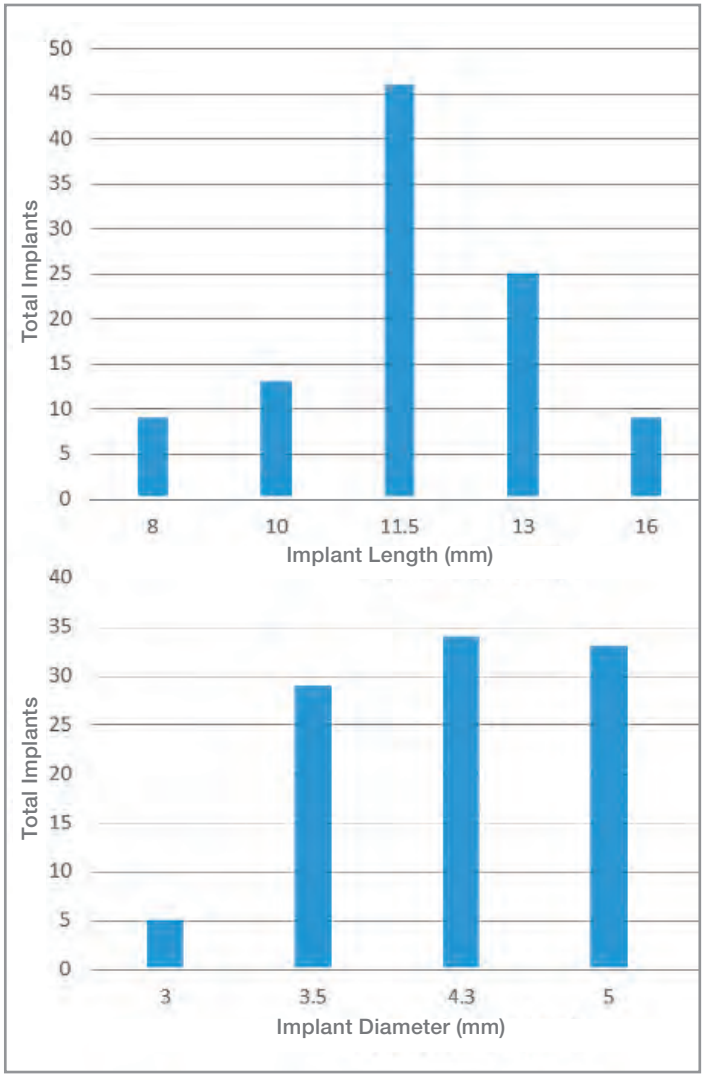


Figure 3: *Frequency of different implant widths and heights used in the study.*

Mean Bone Loss

MBL data from 51 implants (26 males, 25 females) was used to determine average MBL. As described earlier, one implant was chosen for patients who had multiple implants placed. Mean bone loss measures were not calculated for 3-year follow-up because of the small sample size for year 3. The MBL for the study was 0.20 ± 0.02 mm. MBL decreased over time as indicated by an average MBL of 0.23 mm in year one, and an average MBL of 0.18 mm by year two *(Table 6)*.

Year	Number of Implants	MBL (Average ± SD)
1	34	0.23 ± 0.31 mm
2	29	0.18 ± 0.31 mm

Table 6: *MBL per year after controlling for multiple implants.*

Year 1	
Bone Loss	Implants Affected
<0.5 mm	51 (70%)
0.5–1 mm	14 (19%)
>1 mm	8 (11%)
Year 2	
Bone Loss	Implants Affected
<0.5 mm	47 (75.8%)
0.5–1 mm	6 (9.7%)
>1 mm	9 (14.5%)

Table 7: *Amount of bone loss around implants after one and two years.*

Implants were divided into three categories: <0.5 mm bone loss, 0.5–1 mm bone loss, and >1 mm bone loss per year. The results are tabulated below *(Table 7)*. The majority of the implants (over 70 percent) displayed bone loss less than 0.5 mm in each year of follow-up.

In the chart below, implants were grouped into four categories depending on how much MBL they had experienced: 0–0.5 mm, 0.5–1 mm, 1–1.5 mm, and >1.5 mm. On a per-year basis, the majority of implants fell into the 0-0.5 mm MBL category *(Fig. 4)*. The study found that 32.35 percent of the implants (33 out of 102) had bone above the implant collar, indicating maintenance or slight growth of bone over time *(Fig. 5)*.

Figure 5: *Example of implant with bone growth above the implant collar.*

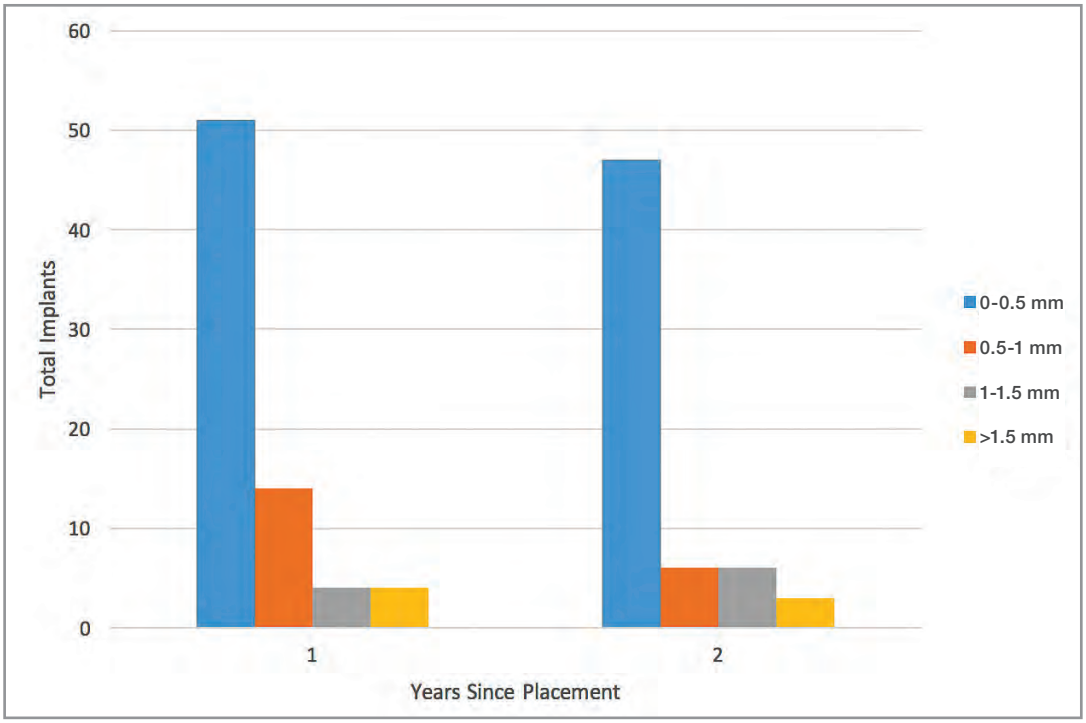


Figure 4: *Bar graph showing the amount of MBL for implants in years since placement.*

Survival Analysis

Of 259 implants placed in patients, two implants failed within one year of placement. Both implants were replaced and no subsequent failures were reported. The Kaplan-Meier survival analysis of implants placed in the study is depicted below *(Table 8)*. The survival analysis showed that one year after implant placement, there was 99.2 percent cumulative survival. Subsequently, no implants were lost for the remaining two years after implants were initially placed.

There were no loosened or broken screws or abutments reported for any of the implants, and no complications were reported with any of the final restorations.

Discussion

The results of this study indicated that over a two-year period, Hahn Tapered Implants demonstrated a 99.2 percent success rate. On a per-year basis, most of the implants experienced 0–0.5 mm MBL. MBL decreased over time, indicating that implants were retaining bone. Our average MBL results (0.20 ± 0.02 mm) are similar to those reported by Toia et al., who found minimal bone loss in both screw-retained (0.35 ± 0.33 mm) and cemented (0.38 ± 0.76 mm) implant restorations, and a 100 percent survival rate over a 16-month period.[11] Our survival rate of 99.2 percent in this study is similar to those reported in studies examining the performance of the Zimmer Tapered Screw-Vent® implant system (Zimmer Dental; Carlsbad, Calif.) and the NobelReplace® implant (Nobel Biocare; Yorba Linda, Calif.). In two different three-year studies, a success rate of 97.6 percent was reported for the Zimmer Tapered Screw-Vent implant system, while a success rate of 96.6 percent was reported for NobelReplace.[9,12]

This study also found that 32.35 percent (33 out of 102 implants) maintained bone above the machined collar. This may be because the Hahn Tapered Implant has a platform-shifted abutment connection that is known to maintain bone, as well as a 1 mm machined collar and microthreads at its neck that help keep crestal bone surrounding the implant healthy. The microthreads may be responsible for transferring optimal amounts of stress and strain to the surrounding bone. In case of bone loss and machined collar exposure, the smooth metal reduces attachment of food and bacteria. These factors may be responsible for the maintenance and growth of bone above the implant collar.

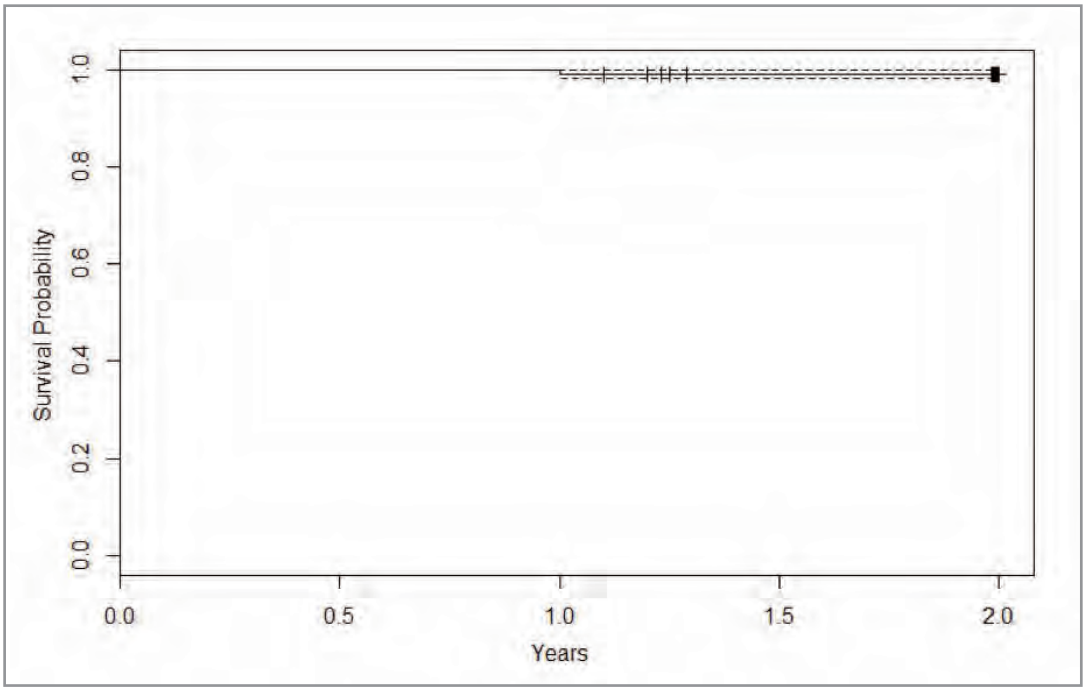


Table 8: *Kaplan-Meier survival analysis measuring implant survival over a two-year time span.*

Limitations

Due to the nature of retrospective studies, this study had incomplete patient information, such as incomplete medical histories and missing follow-up radiographs. Other limitations included losing patients to follow-up and a reduction in usable sample size. In the future, prospective studies with adequate medical and dental history collection and with details about bone type in which implants were placed, will help expand on the results of the current study.

Conclusion

Hahn Tapered Implants have a very high success rate of 99.2 percent. Two years after placement, most patients demonstrated less than 1 mm of MBL. Within the limitations of this retrospective study, our findings suggest that Hahn Tapered Implants are a successful and reliable implant system.

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