Research Article

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A short-term clinical study of marginal bone level change around microthreaded and platform-switched implants

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Purpose: The marginal bone levels around implants following restoration are used as a reference for evaluating implant success and survival. Two design concepts that can reduce crestal bone resorption are the microthread and platform-switching concepts. The aims of this study were to analyze the placement of microthreaded and platform-switched implants and their short-term survival rate, as well as the level of bone around the implants.

Methods: The subjects of this study were 27 patients (79 implants) undergoing treatment with microthreaded and platform-switched implants between October 2008 and July 2009 in the Dental Hospital of Yonsei University Department of Periodontology. The patients received follow-up care more than 6 months after the final setting of the prosthesis, at which time periapical radiographs were taken. The marginal bone level was measured from the reference point to the lowest observed point of contact between the marginal bone and the fixture. Comparisons were made between radiographs taken at the time of fixture installation and those taken at the follow-up visit.

Results: During the study period (average of 11.8 months after fixture installation and 7.4 months after the prosthesis delivery), the short-term survival rate of microthreaded and platform-switched implants was 100% and the marginal bone loss around implants was 0.16 ± 0.08 mm, the latter of which is lower than the previously reported values.

Conclusions: This short-term clinical study has demonstrated the successful survival rates of a microthread and platform-switched implant system, and that this system is associated with reduced marginal bone loss.

Keywords: Alveolar bone loss, Dental implants.

INTRODUCTION

Since Brånemark found that osseointegration occurred between titanium and bone in the mid-1960s [1], several studies have investigated titanium dental implants and their clinical applications. The functional and esthetic restoration of edentulous areas using dental implants is now considered a desirable treatment option. The advantages of implant restoration relate not only to esthetic demands but also to avoiding the involvement of the adjacent teeth. In addition, implant restoration is more comfortable for the patient than conventional dentures and prevents the resorption of the remaining bone that occurs with dentures. As a result, implant treatment has become common and several new implant systems have been developed and are now available in the marketplace. Consequently, dentists are now able to choose an implant that is most appropriate for the condition of each patient.

The ability of the dentist, as well as the quality and quantity

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of available bone, are the primary factors for successful implant therapy. Atwood evaluated changes in the volume of bone after loss of teeth [2], and in 1985, Lekholm and Zarb [3] classified the quality and quantity of remaining bone at the planned implant site. Taking these factors into account, predictable treatments can be assured if the dentist selects the implant system with a high survival rate; the design and features of the implant surface should also be considered. Although it is difficult to define the survival and success of implants, the success rate is currently defined as the proportion of implants that conform to the success criteria after a specific period, and the survival rate as the proportion of implants that do not need to be removed at certain points in time [4].

The resulting crestal bone levels around implants following restoration have been a topic of discussion and used as a reference for evaluating implant success and survival for many years [5,6]. Achieving esthetically pleasing implant therapy is crucially affected by the height of the supracrestal soft-tissue portion, since this is highly relevant to the level of bony support around the fixture [7].

There are many suggested causes for early implant bone loss. Changes in crestal bone height have been attributed to implant loading and concentration of forces, the countersinking procedure during implant placement procedures, and localized soft-tissue inflammation, among others [8]. Implant design can affect occlusal overload and the crestal module, which is the implant body that receives the stress from the implant after loading. The implant system should be designed so that it can best distribute stress to the peri-implant bone in a manner that supports a restoration in function and encourages osseous attachment [9]. Two design concepts that can reduce crestal bone resorption are the microthread and platform-switching concepts. These features are incorporated into the Osstem GS III implant system (Osstem Implant Co., Seoul, Korea), together with a tapered body, self-tapping ability, and internal connection, and a resorbable blast media (RBM) surface. The tapered body is good for ensuring initial stability and controlling the depth and path of insertion [10], and implants with an RBM surface are reportedly associated with a high success rate [11].

The aims of this study were to analyze the placement of microthreaded and platform-switched implants and their short-term survival rate, as well as the effect of the microthreads and platform-switching on the level of bone around the implants.

MATERIALS AND METHODS

The subjects of this study were patients undergoing treatment with Osstem GS III implants (Fig. 1) between October 2008 and July 2009 in the Department of Periodontology of the Dental Hospital of Yonsei University. This study was approved by the Institutional Review Board at Yonsei Dental Hospital (IRB number 2-2009-0025). Overall, 27 patients (15 males, 12 females) were included in this investigation. The subjects' ages ranged from 19 to 77 years (mean, 58.6±13.5 years). In total, 79 implants were inserted (Table 1). The presence of systemic disease among the patients was evaluated using a questionnaire. Bone quality and quantity were evaluated during the operation in accordance with the Lekholm and Zarb index. Among the 79 implants, 30 were inserted into the maxilla and 49 were inserted into the mandible. Eleven implants were placed in the anterior teeth area and 68 were placed in the posterior teeth area. Thus, most of the implants were placed in the posterior mandible (Table 2). Hypertension was the most common general disorder in this patient group.

The patients were followed for more than 6 months after the final setting of the prosthesis, at which time periapical radiographs were taken using the parallel cone technique with an Extension Cone Paralleling device. All films were de-

Figure 1. Illustration of GS III implant.

Table 1. Distribution of implants according to patients' age and gender.

Age (yr)	Male		Female		Total	
	No. of patients	No. of implants	No. of patients	No. of implants	No. of patients	No. of implants
19-29	1	1	0	0	1	1
30-39	1	1	0	0	1	1
40-49	3	4	0	0	3	4
50-59	4	15	4	11	8	26
60-69	3	20	4	8	8	28
>70	3	10	4	9	6	19
Total	15	51	12	28	27	79

Table 2. Distribution of implants according to position.

	Maxilla	Mandible	Total
Incisor	2	4	6
Canine	2	3	5
1st premolar	7	5	12
2nd premolar	3	8	11
1st molar	7	15	22
2nd molar	9	14	23
Total	30	49	79

Values are presented as no. of implants.

Table 3. Distribution of bone quality.

Bone quality	D1	D2	D3	D4	Unknown	Total
Maxilla	0	0	22	5	3	30
Mandible	4	24	10	1	10	49
Total	4	24	32	6	13	79

Table 4. Distribution of bone quantity.

Bone quantity	A	B	C	D	Unknown	Total
Maxilla	0	19	8	0	3	30
Mandible	0	27	10	2	10	49
Total	0	46	18	2	13	79

veloped using the same automatic processor in accordance with the manufacturer's instructions.

This study was carried out retrospectively using the patients' charts, from which the following information was collected: age, gender, distribution of the implants, general health disorder, reasons for tooth loss, bone quality and quantity, and implant diameter and length. Most of the teeth had been lost because of periodontal problems, although in some cases the cause was unknown. Type D3, B bone was common in the maxilla, and type D2, B bone in the mandible, according to the Lekholm and Zarb index (Tables 3 and 4). The distributions of implant length and diameter are given in Tables 5 and 6.

Survival rate

The survival rate was evaluated according to the criteria reported by Buser et al. [12] as follows:

1. The absence of persistent subjective complaints, such as pain, foreign body sensation, and/or dysesthesia.
2. The absence of recurrent peri-implant infections with suppuration.
3. The absence of mobility.
4. The absence of continuous radiolucency around the implant.
5. The possibility for restoration.

Table 5. Distribution of implant length.

Length (mm)	Maxilla		Mandible		Total
	Anterior	Posterior	Anterior	Posterior	
7	0	0	0	5	5
8.5	0	0	0	6	6
10	0	8	0	9	17
11.5	4	16	2	21	43
13	0	2	5	1	8
Total	4	26	7	42	79

Table 6. Distribution of implant diameter.

Diameter (mm)	Maxilla		Mandible		Total
	Anterior	Posterior	Anterior	Posterior	
3.5	2	0	1	2	5
4	2	3	6	11	22
4.5	0	10	0	10	20
5	0	13	0	19	32
Total	4	26	7	42	79

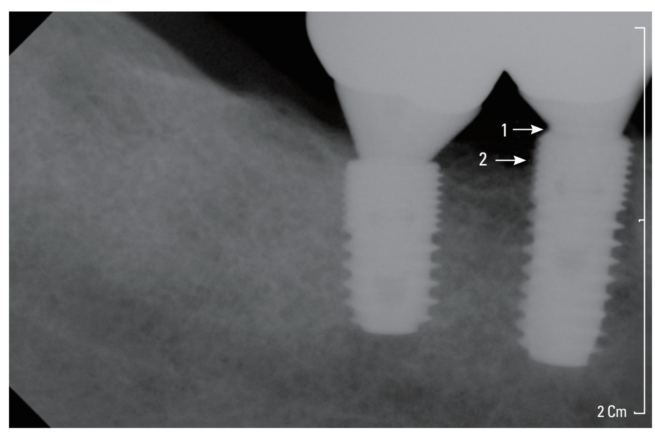

Figure 2. The reference point with the periapical radiograph. Arrow 1 marks the reference and arrow 2 marks the lowest observed point of contact between the marginal bone and the fixture.

Measurement of changes in marginal bone level

After digitization, all files were transferred to a personal computer and examined on the same monitor. The Starpacs System (Infinitt Co., Seoul, Korea) was used as the image-analysis software. The marginal bone level was measured (to the nearest 0.01 mm) from the reference point to the lowest observed point of contact between the marginal bone and the fixture. The reference point of the fixture was the top of the fixture (Fig. 2). The amounts of bone loss on the mesial and distal sides of the implants were measured and the average value was used. Calibration was performed with a known distance between screws (1.6 mm) as the reference length [13]. The radiographs were magnified to enable precise measure-

JPIS Journal of Periodontal & Implant Science

Table 7. Marginal bone level.

	Baseline[a)]	F/U[b)]	Change between baseline and F/U
Mean bone loss (mm)	0.05	0.21	0.16
Standard deviation (mm)	0.02	0.10	0.08

F/U, follow-up.
[a)]At the time of fixture installation, [b)]At >6 months follow-up after prosthesis delivery.

ments. Only the amount of vertical bone loss was measured. Comparisons were made between radiographs taken at the time of fixture installation and those taken at the follow-up visit more than 6 months after final prosthesis delivery.

Statistical analysis

The change in marginal bone level around microthreaded and platform-switched implants was analyzed using paired *t*-testing. Statistical software (SPSS ver. 16.0, SPSS Inc., Chicago, IL, USA) was used for statistical analysis. The data are presented as mean ± SD values, and the level of statistical significance was set at $P<0.05$.

RESULTS

Survival rate

No implant was lost during the observation period (11.8 ± 1.8 months on average), and none of the patients reported subjective complaints after implant installation. No peri-implant infection, implant mobility, or radiolucency around the implant was detected. Therefore, according to the survival criteria reported by Buser et al. [12], the implant survival rate in our cohort was 100%.

Changes in marginal bone level

The mean follow-up time was 11.8 months after fixture installation and 7.4 months after prosthesis delivery. The radiographic analysis revealed a significant marginal bone loss of 0.16 ± 0.08 mm at the follow-up visit ($P<0.05$; Table 7). More bone was resorbed at the distal than the mesial side.

DISCUSSION

Many recent studies have found no differences in the success and failure rates among various root-formed osseous integrated dental implant systems [14]. Implant failure is divided into early failure (occurring before loading) and late failure (destruction of osseointegration). The reported percentages of late failures have varied widely, from 2.1 to 11.3% [10]. In the present study, the survival rate of microthreaded and platform-switched implants was 100%. However, because the study period was short, further investigation is required to evaluate the survival rate over longer durations.

Albrektsson et al. [5] suggested the following success criteria: 1) the change in marginal bone level in the first year should be less than 1 to 1.5 mm, and 2) ongoing annual bone loss should be less than 0.2 mm. In their 15-year study, Adell et al. [15] reported a crestal bone loss of 1.2 mm for Brånemark System implants for the first year. In the present study, the marginal bone loss was 0.16 ± 0.08 mm, which is lower than previously reported data.

Two design concepts that can reduce crestal bone resorption are the microthread system and the platform-switching concept. The microthread system enhances the contact area between implant and bone. A study of the mechanical properties of bone [16] found it to be more resistant to compressive forces than tensile and shear forces (its resistances to the latter were reportedly 30% and 65% lower, respectively, than its resistance to compression). The crestal module design is particularly important with regard to minimizing bone loss, because it can decrease the shear force exerted on the crestal bone [17]. Therefore, it has been hypothesized that bone loss slows down at the first thread of the implant fixture when the force changes from a crestal shear force to a compressive force induced by the thread itself [18]. In addition, correlations were found between the amount of bone loss and the length of the machined surface for various implant systems, thus relating bone loss to the level of the first thread [19].

Hansson utilized a 3D mathematical model and axisymmetric finite element analysis to determine the ideal rough surface. He hypothesized that the surface roughness or the retentive elements such as microthreading increases the resistance of marginal bone to bone loss by improving the interlocking force between the implant surface and the crestal bone [20]. Abrahamsson and Berglundh [21] suggested that the microthread configuration offered improved conditions for osseointegration in a study using dogs. In that study, the degree of bone-implant contact within the marginal portion of the implants was significantly higher for the test (microthread) implants (81.8%) than for the control implants (72.8%).

The results of a study that used two types of Astra implants (one with the microthreads on the coronal portion of the fixture and one without) suggested that microthreads have the effect of maintaining the marginal bone loss in the presence of loading forces [17]. The amount of peri-implant bone loss was significantly greater around implants without microthreads than around those with microthreads during the examination period.

The platform-switching concept was developed to control bone loss after implant placement. This refers to the use of an abutment of a smaller diameter connected to an implant neck of a larger diameter. This connection shifts the perimeter of the implant-abutment junction (IAJ) inward, toward the central axis (the middle of the implant), in order to improve the force distribution. Quirynen et al. [22] suggested that bacterial leakage occurs through the microgap of the IAJ. Ericsson et al. [23] found histologic evidence that an inflammatory cell infiltration is located 1 to 1.5 mm adjacent to the IAJ after implant placement. To protect the underlying bone from this inflammatory cell infiltration and microbiologic invasion, 1 mm of healthy connective tissue is needed to establish a biologic seal comparable to that around natural teeth [23,24]. This movement of the IAJ is also believed to shift inflammatory cell infiltration to the central axis of the implant and away from the adjacent crestal bone, which is thought to restrict crestal bone resorption [8]. Indeed, Hurzeler et al. [25] reported that the concept of platform switching does appear to limit crestal resorption and preserve the peri-implant bone level. They found that the amount of bone loss was significantly lower in the platform-switching group.

Lopez-Mari et al. [26] found that platform switching is capable of reducing or eliminating crestal bone loss to 1.56± 0.70 mm. It also appears to help to maintain the width and height of crestal bone and the crestal peak between adjacent implants, and reduces circumferential bone loss. It was concluded that the implant design modifications involved in platform switching offer multiple advantages and potential applications, including situations in which a larger implant is desirable but the prosthetic space is limited, and some implants are desirable in the anterior zone where preservation of the crestal bone can lead to improved esthetics .

From a review of the literature, Kwon et al. [27] concluded that the marginal bone loss associated with a flat-top implant is 1.0 to 1.3 mm at 1 year post-implantation, even in the presence of an improved surface [28-30]. In contrast, the marginal bone loss with a microthread, conical seal, and platform-switched design was found to be 0.11 to 0.24 mm [17,31]. Those authors concluded that the marginal bone levels of the subjects in their study (0.16 to 0.17 mm) were comparable to those of previous studies. Similarly, in the present study, the mean amount of marginal bone loss was small, and it can therefore be assumed that microthreaded and platform-switched implants have the ability to reduce marginal bone loss because of certain features of the implant design.

Adell et al. [32] stated that the success of implants should be evaluated 1 year after prosthesis installation, because by then almost all crestal bone loss following abutment installation would have ceased. Additional long-term studies are required to confirm that the microthreaded and platform-switched implant system has considerable potential to reduce crestal bone resorption.

Radiographic analysis can lead to false conclusions when analyzing small, peri-implant bone level changes. Bragger et al. [13] and Siegele and Soltesz [33] suggested that the implant thread is a useful aid to radiograph interpretation. In the present study, calibrations were performed with the aid of a fixture with a known length. The accuracy of using the thread pitch distance as an internal reference is reported as being within 0.3 mm [34].

The findings of this study suggest that the microthreaded and platform-switched implant system is associated with successful short-term survival rates and reduces marginal bone loss. Further long-term, post-implantation studies are required.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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