Peri-implant marginal bone loss based on the thread size of implant neck area : A 1-year prospective study after loading

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Peri-implant marginal bone loss based on the thread size of implant neck area : A 1-year prospective study after loading

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ABSTRACT

Peri-implant marginal bone loss based on the thread size of implant neck area: A 1-year prospective study after loading

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The aim of this investigation was to compare the amount of marginal bone loss between two types of implants, both of which have threads up to the top of the neck area, but one with micro-threads and the other with macro-threads, and to analyze the effect the two different sized threads have on marginal bone, clinically.

The two groups of implants used in this study differ in the thread size of the implant neck area. One (Group A) has bigger size neck thread of 0.35mm depth and 0.6mm pitch, and the other (Group B) has smaller size neck thread of 0.15mm depth and 0.3mm pitch in the 3.0mm neck area. Implants from each group were placed adjacent to each other in the partially edentulous premolar and molar area of 13 patients. In order to minimize the influence the condition of the peri-implant mucosa and plaque accumulation may have on bone loss, adequate oral hygiene instructions were given and periodic clinical examinations of peri-implant mucosa and professional plaque control were performed. Bone loss around each implant was analyzed after one year of functional loading.

The average bone loss in Group A was 0.192 ± 0.131mm, and in Group B was 0.147 ± 0.156mm, after 1-year of functional loading. Implants with micro-threads had slightly less marginal bone loss. However, there was no significant difference statistically (p=0.414). None of the implants had any complication during the observation period. And there was no significant difference statistically in mPI and mBI of both study groups.

According to present study, it seems that the macro-threads in the neck portion of implant have similar ability for marginal bone preservation compared with micro-threads. However, this study has the limitation of study design.

Key words: thread size, marginal bone loss, prospective study

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I. INTRODUCTION

Wiskott and Belser reported that adequate mechanical stimulation is the important requirement for successful integration of load bearing surfaces (Wiskott and Belser, 1999). From a biomechanical aspect, retention elements such as the thread on the implant neck area provide mechanical stimulation required to maintain the marginal bone level (Hansson, 1999). In a long-term clinical study, screw type implants with thread had a significantly higher survival rate compared to cylinder type implants without thread (Karoussis et al., 2004).

Several researches referred that certain pitch distance of threads has benefit on preservation of peri-implant bone (Kong et al., 2009; Motoyoshi et al., 2005). Also, according to a finite element study, very small thread with favorable profile can be effective on stress distribution in the bone as much as common size thread can(Hansson and Werke, 2003).

Recently, the role of micro-thread in the neck portion has been researched in numerous studies (Abrahamsson and Berglundh, 2006; Berglundh, Abrahamsson, and Lindhe, 2005; Hansson and Werke, 2003; J. J. Kim et al., 2010; Lee et al., 2007; Song et al., 2009). Experimental studies have verified the advantages of micro-thread compared with a smooth neck, in terms of established bone-to-implant contact and marginal bone level maintenance (Abrahamsson and Berglundh, 2006; Berglundh, Abrahamsson, and Lindhe, 2005). According to clinical studies, the presence of micro-thread in implant neck area has shown satisfactory preservation of peri-implant marginal bone (Lee et al., 2007). In other clinical studies, the beginning location of the thread in the implant neck area plays an important role in stabilization of peri-implant marginal bone (Jung, Han, and Lee, 1996; Song et al., 2009).

The question may arise as to whether the difference in the size of the thread can lead to a difference in the maintenance of peri-implant marginal bone in cases where the location of the thread is identical. However, there were few clinical studies for the role of thread size.

The aim of this investigation was to compare the amount of marginal bone loss between two types of implants, both of which have threads up to the top of the neck area, but one with micro-threads and the other with macro-threads, and to analyze the effect the two different sized threads have on marginal bone, clinically.

II. MATERIALS AND METHODS

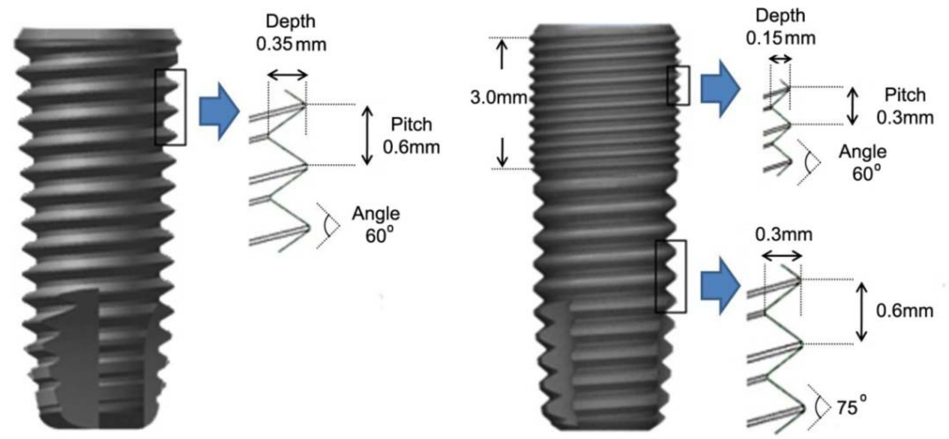
This study was approved by the Institutional Review Board of Yonsei University. Patients were informed of the study procedures and all gave written informed consent.

1. Materials

1) Implants

The two groups of implants used in this study differ in the thread size of the implant neck area. One (Group A: EZ Plus Internal, Megagen, Seoul, Korea.) has a uniform thread pitch from the apex to the neck area, and the other (Group B: Megafix Internal, Megagen, Seoul, Korea.) has threads in the 3.0mm neck area smaller size in both pitch and depth(Figure 1). The implants of two groups are single threaded screw with V-shape thread (Abuhussein et al., 2010). As a matter of convenience, neck thread of Group A is designated ‘macro-thread’ and Group B is designated ‘micro-thread’.

The surface treatment method (implants made of commercially pure titanium with resorbable blast media) and implant-abutment connection type (conical seal type with an internal slope of 11°) of both groups of implants are identical.



Group A **Group B**

Figure 1. Schematic presentation of the implants

Group A: Macro-thread implant; Group B: Micro-thread implant

2) Patient selection

Patients who required implant therapy were recruited between July 2007 and June 2008 to the Department of Periodontology, Gangnam Severance Dental Hospital, and were selected as subjects for this study. All patients were in good general health and none of the patients had cardiovascular disease or diabetes. In total, 13 patients (8 males & 5 females, 26 implants) participated in the study, with a mean age of 57.8 years and a range of 23 – 65 years. All patients had the ability to understand and perform the oral hygiene maintenance procedures as instructed.

2. Methods

Treatment procedure, taking radiograph and measurements followed previous protocols of our group (J. J. Kim et al., 2010; T. H. Kim et al., 2009; Kwon et al., 2009; Lee et al., 2007; Lee et al., 2009; Lee, Park, and Moon, 2005, 2006; Song et al., 2009).

1) Treatment procedure

All surgeries were performed using a two-stage method. Implants from each group were placed adjacent to each other in the partially edentulous premolar and molar area of each patient. The mesiodistal location of each implant was randomly determined. The location and characteristics of each type of implant are illustrated in

Table 1. The second surgery was performed six and three months later for maxillary and mandibular implants, respectively. The prostheses were delivered three weeks after the second surgery. Patients were recalled every six months for oral hygiene evaluation, professional plaque control, and review of self-performed oral hygiene instruction.

Table 1. Distribution of the locations and dimensions of implants

Subject	Tooth Number	Group	Fixture Diameter/ Length(mm)
1	35	A	4.0/8.5
	36	B	4.8/8.0
2	26	A	5.0/8.5
	27	B	4.8/8.0
3	15	A	4.0/10
	14	B	3.8/10
4	47	A	5.0/10
	46	B	4.8/8.0
5	36	A	4.0/8.5
	37	B	4.3/8.0
6	25	A	4.0/10
	26	B	4.8/8.0
7	14	A	4.0/10
	15	B	4.3/10
8	25	A	5.0/13
	26	B	4.8/10
9	25*	A	5.0/11.5
	27*	B	4.8/10
10	35	A	4.0/10
	36	B	4.8/10
11	15	A	5.0/8.5
	14	B	4.8/10
12	25	A	5.0/8.5
	24	B	4.8/10
13	36	A	4.0/8.5
	37	B	4.3/8.0

* In one patient, the implants were not placed immediately adjacent to each other and were splinted to fabricate three-unit bridges.

2) Radiographic examination

Radiograph taking and measurement followed previous protocols established by our group. In brief, periapical radiographs (Kodak Insight, film speed F, Rochester, NY, USA.) were taken one day after implant placement, immediately after the second surgery, immediately after prosthesis delivery, and one year after functional loading. Radiographs were taken with an XCP device (Extension cone paralleling Kit, Rinn, Elgin, IL, USA.) using the parallel cone technique (70 kV, 8 mA, 0.250 s). A 5.5 mm spherical metal bearing was placed to aid length measurement. All films were developed using the same automatic processor (Periomat, Durr Dental, Bietigheim-Bissingen, Germany.) following the manufacturer's instructions. Films were digitized using a digital scanner (EPSON GT-12000, EPSON, Nagano, Japan.) at an input resolution of 2400 dpi with 256 gray scale.

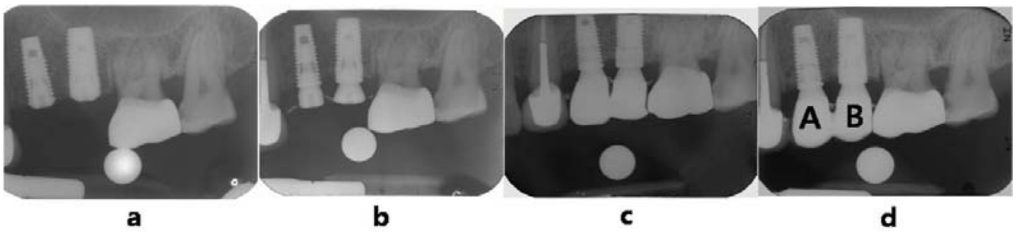


Figure 2. Intra oral radiographs of implants

a: 1st surgery; b: 2nd surgery; c: Prosthesis delivery; d: 1-year follow up

(A: Macro-thread implant; B: Micro-thread implant)

3) Measurement of marginal bone level change

Following digitization, all images were transferred to a personal computer (Processor, Intel Core2 Duo E8200, Santa Clara, CA, USA; operating system, Windows XP Professional 2002, Redmond, WA, USA.). The same monitor (Flatron LX1717, LG, Seoul, Korea.), set to a resolution of 1280 × 1024, was used to examine the digitized radiographs. The room was kept dark throughout the computer-assisted radiographic measurement process.

Bone loss was measured by comparing the radiographs taken immediately after prosthesis delivery to those taken one year after functional loading. The marginal bone height was measured as the distance between the reference point and the most apical point of the marginal bone level. The reference point was the border between the polished surface and the rough surface of the fixture. Calibration was performed using the known distance of the spherical metal bearing (5.5mm). Measurements were taken to the nearest 0.01 mm using computer software (UTHSCSA Image Tool, Version 3.00, University of Texas Health Science Center in San Antonio.). Bone loss was measured at the mesial and distal peri-implant sites, and their average values were used.

4) Follow-up parameters

At the 1-year follow-up visit, implants were evaluated for pain, discomfort, and implant-related infection. An implant was deemed as surviving when it was stable, functional, and asymptomatic. To rule out the possible influence of inflammatory changes of the peri-implant tissues on the surrounding marginal bone, the modified plaque index (mPI) and modified sulcus bleeding index (mBI) were measured at four aspects around each implant (Mombelli et al. 1987). Averages of the four obtained plaque and sulcus bleeding index values were calculated to represent the respective values for each implant.

5) Statistical analysis

D’Agostino–Pearson test was used to test the normality of the distribution. The normality of the distribution of both groups was accepted. Wilcoxon's signed-rank test was used to analyze the differences in peri-implant marginal bone loss between the two groups. A computer software (MedCalc for Windows, version 11.2.1.0, MedCalc Software, Mariakerke, Belgium.) was used to process the data. The values were deemed statistically significant if the p-value was lower than 0.05.

III. RESULTS

1. Clinical examination

The implants of all of the patients were well maintained at periodic follow-up checks. All of the implants functioned normally during the observation period and there were no signs of pain, swelling, pus discharge, mobility.

2. Marginal bone level changes

The mean marginal bone losses (Group A: 0.192 ± 0.131mm; Group B: 0.147 ± 0.156mm) were not statistically significant between the two groups ($p=0.414$).

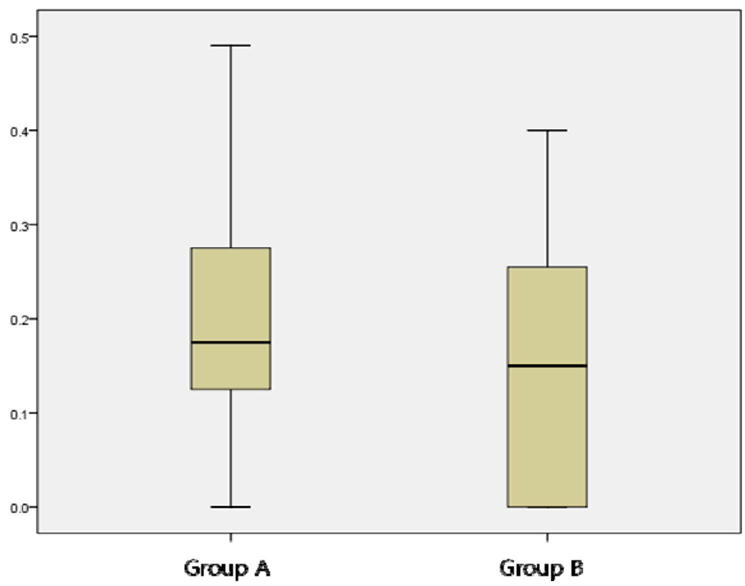


Figure 3. Box plot of the bone loss around implants

Table 2. Marginal bone loss (mm) around implants in Group A and B

Bone loss		
	Type of implant	
Subject	Group A	Group B
1	0.14	0.32
2	0.18	0.17
3	0.22	0.01
4	0.00	0.00
5	0.18	0.40
6	0.28	0.38
7	0.10	0.00
8	0.28	0.15
9	0.30	0.26
10	0.49	0.00
11	0.13	0.00
12	0.00	0.00
13	0.23	0.23
Mean	0.19	0.15
Standard deviation	0.14	0.16
Median	0.18	0.15
95% confidence interval for the median	0.12-0.28	0-0.29
p-value	0.414	

3. Evaluation of peri-implant soft tissue

The average plaque index of the Group A was 0.46, while the average of the Group B was 0.48. The average mucosal index was 0.35 and 0.25 for the Group A and Group B, respectively. The mPI and mBI for each type of implant is illustrated in Table 3. No significant differences were found between the two groups for either the plaque accumulation or sulcus bleeding (mPI: p=0.655; mBI: p=0. 458).

Table 3. Modified plaque index (mPI) and modified sulcus bleeding index (mBI) of implants in two groups

mPI			mBI		
	Type of implant			Type of implant	
Subject	Group A	Group B	Subject	Group A	Group B
1	0.00	0.25	1	0.00	0.25
2	0.25	0.25	2	0.00	0.50
3	0.25	0.25	3	0.75	0.50
4	1.00	1.00	4	0.00	0.00
5	1.00	1.00	5	0.25	0.25
6	0.00	0.25	6	0.50	0.00
7	0.25	0.25	7	1.25	0.25
8	1.00	1.00	8	0.75	0.75
9	0.00	0.00	9	0.25	0.00
10	0.00	0.00	10	0.25	0.00
11	0.75	0.50	11	0.25	0.00
12	0.50	0.25	12	0.00	0.25
13	1.00	1.25	13	0.25	0.50
Mean	0.46	0.48	Mean	0.35	0.25
Standard deviation	0.43	0.43	Standard deviation	0.38	0.25
Median	0.25	0.25	Median	0.25	0.25
95% confidence interval for the median	0-1.00	0.25-1.00	95% confidence interval for the median	0-0.62	0-0.50
p-value	0.655		p-value	0.458	

IV. DISCUSSION

Placing micro-threads at the implant neck greatly increases the ability of an implant to resist axial loads, and the mechanical stimulus provided by the micro-threads helps to preserve peri-implant marginal bone (Hansson, 1999). In a 3-year prospective study performed by our group, Lee et al (2007) reported that peri-implant marginal bone loss was reduced in Astra Tech implants when micro-threads were present in the implant neck area. However, in this study the implant with micro-thread had a conical shape neck area whereas the implant without the micro-thread had a straight shape neck area. In a following study, Kim et al (2010) compared two implants, both of which had micro-threads, but one of them with a conical shape neck area and the other with a straight shape neck area. The study revealed that there was no difference in the amount of bone loss based on the shape of the implant neck area. Therefore we can infer that it is the presence or absence of micro-threads which has an effect on bone loss.

In a clinical research of four types of implants, Jung et al (1996) reported that bone loss occurred around the smooth surface of the neck area above the first threads, i.e., the first macro-thread. Also, Song et al (2009) performed a study on implants with micro-threads in the neck area, identical except for difference in the location where the threads begin. In this study, implants on which the threads begin at the top showed a lesser amount of bone loss compared with implants on which the threads begin 0.5mm from the top. These results signify that the location of the threads in the implant neck area can also be a factor affecting the preservation of marginal bone.

Since the effects the presence, absence, and location of the thread have on marginal bone have been confirmed, a following study was planned in order to examine thread size as another factor. This study was carried out to compare macro-threads and micro-threads on implant neck area in cases where the location of the thread is identical.

In the present study, difference of thread size is subdivided for two categories of thread depth and thread pitch. Thread depth means the distance from the tip of the thread to the body and thread pitch means the distance from the center of the thread to the center of the next thread.

One finite element study which compared effect of thread depth on marginal bone found that there was no significant difference of stress distribution according to thread depth of 0.1mm and 0.4mm, if the thread profile is favorable (Hansson and Werke, 2003).

On the other hand, results of studies for thread pitch are controversial. Chun et al (2002) concluded that screw pitch did not function as an important factor in reducing maximum effective stress when its dimensions were smaller than 0.9 mm. Also, Kong et al (2009) concluded that thread pitch exceeding 0.8mm were optimal selection by biomechanical consideration. In another finite element study that compared with

0.5mm, 1.0mm and 1.5mm of pitch distance, the 0.5mm pitch had more favorable stress distribution. And they concluded that the maximum effective stress decreased as thread pitch decreased gradually (Motoyoshi et al., 2005). Chung et al found that the 0.5mm pitch implant had less bone loss than the implants with the 0.6mm pitch in a dog study (Chung et al., 2008). However, these studies do not have result about implant that has pitch distance of below 0.5mm.

In our study, Group A implant has bigger size neck thread of 0.35mm depth and 0.6mm pitch and Group B implant has smaller size neck thread of 0.15mm depth and 0.3mm pitch. In order to minimize the influence the condition of the peri-implant mucosa and plaque accumulation may have on bone loss, adequate oral hygiene instructions were given and periodic clinical examinations of peri-implant mucosa and professional plaque control were performed. The average bone loss in Group A was 0.192mm, and in Group B was 0.147mm, after 1-year of functional loading. Implants with micro-threads had slightly less marginal bone loss. However, there was no significant difference statistically. None of the implants had any complication during the observation period. And there was no significant difference statistically in mPI and mBI of both study groups.

The results of this study can be interpreted as the thread size at the implant neck area not being the determining factor in the amount of marginal bone loss, since both groups of implants have the same rough surface. Also the amount of bone loss was minor likely due to the fact that both groups of implants have internal conical seal type fixture-abutment connections which have advantages in the marginal bone preservation (Engquist et al., 2002; Hansson, 2000; Norton, 1998; van Steenberghe et al., 2000). Therefore, it is possible that the beneficial effects of the rough surface and conical fixture-abutment interface on marginal bone-level maintenance overwhelmed the additional effects of micro-thread.

In another perspective, macro-threads which begin at the top of the implant neck can be assumed to be able to distribute stress under load and maintain marginal bone as much as micro-threads. However, because the present study had small sample size and short follow up period, more long term research is needed for a clear conclusion.

V. CONCLUSION

There was no significant difference between macro-thread neck implant and micro-thread neck implant in terms of marginal bone loss after 1 year of loading. It seems that the macro-threads in the neck portion of implant have similar ability for marginal bone preservation compared with micro-threads. However, this study has the limitation of study design.

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국문 요약

치경부 나사선 크기가 다른 두 임플란트를 인접해 식립한 경우 임플란트 주위 변연골 소실 비교분석

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이 연구의 목적은 임플란트 치경부의 나사선 크기가 임플란트 주위 변연골 유지에 어떠한 영향을 미치는지 평가하는 것이다.

0.6mm 의 간격과 0.35mm 높이의 큰 치경부 나사선을 가진 임플란트와 0.3mm 의 간격과 0.15mm 높이의 작은 치경부 나사선을 가진 임플란트를 인접하게 총 13 명의 환자의 무치악 구치부에 식립하였다. 이 후 상부 보철물 연결시의 방사선 사진과 보철물 연결 1 년 후의 방사선 사진 사이의 임플란트 주위 변연골 소실량을 비교하였다. 또한 임플란트 주위 점막 염증이 임플란트 주위 변연골에 미치는 영향을 최소화하기 위해 구강

위생 교육과 관리를 정기적으로 시행하였고 정기 검진 시 치태지수와 점막지수를 측정하였다.

각 임플란트의 변연골 소실량 평균은 큰 치경부 나사선 임플란트에서 0.192 ± 0.131mm, 작은 치경부 나사선 임플란트에서 0.147 ± 0.156mm 이었으며 Wilcoxon’s signed-rank test 를 이용하여 분석한 결과, 통계적으로 유의할 만한 차이를 보이지 않았다(p=0.414). 또한 보철물 연결 1 년 후의 치태지수와 점막지수는 두 임플란트에서 유의할 만한 차이를 보이지 않았다(치태지수: p=0.665, 점막지수: p=0.458).

이번 연구 결과로 볼 때, 상대적으로 큰 치경부 나사선을 가진 임플란트도 작은 치경부 나사선을 가진 임플란트와 비슷한 변연골 유지 능력을 가진 것으로 볼 수 있다. 하지만 명확한 결론을 얻기 위해서는 장기적인 관찰과 추가적인 연구가 필요할 것으로 보인다.

핵심 단어: 나사선 크기, 변연골 소실량, 전향적 연구