Prospective comparative anlaysis of marginal bone levels around implants with different neck design: Conical versus straight design

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감사의 글

본 논문이 완성되기 까지 지속적인 지도와 세심한 배려를 해주신 문익상 교수님과 논문 작성과 심사에 많은 조언과 격려를 주신 김종관 교수님, 박광호 교수님께 깊은 감사를 드립니다. 바쁘신 와중에도 논문 완성에 큰 도움을 주신 이동원 교수님께도 큰 감사를 드립니다.

자료수집과 정리에 도움을 준 강남세브란스 치과전문병원 치주과 전공의 강영일, 이은경, 이동원 남대호 선생에게 심심한 감사를 드립니다. 4년 동안 같이 생활하며 논문 작성에도 수많은 도움을 준 송동욱 선생에게 특별한 감사를 드립니다. 또한, 의국에서 많은 응원과 격려를 해주신 보철과 강동호 선생에게도 감사의 말을 전합니다.

항상 든든한 힘이 되어주신 아버지, 어머니, 형님, 형수님께도 말로는 표현하지 못할 감사의 마음을 전하고 싶습니다. 마지막으로 제 주변에서 저를 생각해 주시는 모든 분들께 감사의 마음을 전합니다.

감사합니다.

2009년 7월

김 정 주

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Abstract

Prospective comparative anlaysis of marginal bone levels around implants with different neck design: Conical versus straight design

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The aim of the present prospective clinical study was to evaluate the effect of the conical neck design with Microthread™ on the marginal bone level of the fixture by comparing the amount of marginal bone loss between the Astra Osseospeed™ 4.0s and 5.0 implant types.

Two types of implant, one with cylindrical shape and a diameter of 4.0mm (4.0s), and the other with conical neck design and a diameter of 4mm at the apical portion, which increases at the marginal collar, thus making the coronal diameter 5mm (5.0), were placed adjacent to each other in the partially edentulous areas of each of 10 patients. Bone loss around each implant was analyzed after one year of functional loading, and gingival parameters (modified plaque index and modified mucosal index) of the peri-implant soft tissue were evaluated. The amount of peri-implant bone loss after loading and gingival parameters were compared using the Wilcoxon signed-rank test.

The mean amount of peri-implant bone loss after 1-year of functional loading were 0.058mm ± 0.097 and 0.067mm ± 0.152 in the 4.0s and 5.0 group, respectively. There was no statistically significant difference between the two groups in individual patients (p = 0.833), And no significant differences were found between the two groups for the gingival parameters (mPI; p = 0.4973, mMI; p = 0.4609).

According to the present study, the effects of the conical implant-abutment interface, Microthread™ and rough surface on marginal bone level maintenance might compensate for the effects of conical neck design.

Key words: implant design, marginal bone level, prospective study

Prospective comparative anlaysis of marginal bone levels around implants with different neck design: Conical versus straight design

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I. Introduction

The peri-implant marginal bone is an important parameter in determining the success of an implant.[1] Recently, commercial implants were designed that seek to maintain peri-implant marginal bone levels through modulating the implant-abutment interface, surface treatment, thread use, and the implant fixture shape.[2]

Conical neck implants were developed with the goal of achieving improved adaptation to the alveolar margins of fresh extraction sites.[3] However, the effects of the gross fixture design (e.g. conical neck design vs. straight design) on peri-implant marginal bone maintenances are controversial.[3-6] Marginal bone levels around Brånemark conical implants (Nobel Biocare, Göteborg, Sweden) which have a machined conical surface, are reportedly positioned more apically[3] and result in increased marginal bone loss[4] compared to standard or self-tapping implants. Thus, Quirynen et al. and Malevez et al concluded that such implants are nonideal for single-tooth replacement where the conical part is infraosseous.[3,4]

In contrast, studies with Astra Tech Single Tooth implants (Astra Tech AB, Mölndal, Sweden) have shown stable bone level maintenance (0.5 ± 0.11mm) after 1 year or minimal marginal bone loss (0.24 ± 0.13mm) after 3 years of loading.[6,7]

Such contradictory results might be due to surface treatment or the use of Microthread™ on the conical part of the implant in the latter studies. Brånemark System implants have a machined conical neck, without any retentive factors, which would result in marginal bone loss. In contrast, Astra Single tooth implants have a rough surface and Microthread™, which would prevent marginal bone loss.[8] Thus, direct comparison between the two systems is not logical in terms of the gross fixture design.

To investigate the pure effect of conical neck design on marginal bone level maintenance, it is necessary to use equivalent conditions, such as loading, thread use, fixture-abutment interface, and surface treatment. Astra Osseospeed™ 4.0s and 5.0 implants share the same thread design, surface treatment, and implant-abutment interface, but have different coronal fixture designs. Osseospeed™ 5.0 has a conical neck, while the 4.0s has a straight design. The aim of the present prospective clinical study was to evaluate the effect of the conical neck design with Microthread™ on the marginal bone level of the fixture. This was done by comparing the amount of marginal bone loss between the Astra Osseospeed™ 4.0s and 5.0 implant types.

II. Materials and Methods

1. Materials

1) Patient selection

Subjects were selected from patients who had undergone periodontal therapy including oral hygiene instruction, scaling, root planning, extraction and periodontal surgery at the department of Periodontology at Gangnam Severance Hospital (College of Dentistry, Yonsei University, Seoul, Korea). Patients had received implant surgeries from November 2006 to October 2007. The study protocol was approved by the Institutional Review Board of Yonsei University. Patients were informed of the study procedures and all provided informed consent. In total, five males and five females participated in the present study with a mean age of 61.1 years (range 49-71 years). Nine patients showed good general health and one patient had hypertension that was well-controlled with medication.

2) Implants

Astra Tech Osseospeed™ Implants (Astra Tech AB, Mölndal, Sweden) were used in this study. The Osseospeed™ 4.0s fixture (4.0s) has a straight shape with a 4.0 mm diameter. The coronal portion of the Osseospeed™ 5.0 fixture (5.0) is tapered with Microthread™. The apical part of the fixture 5.0 has 4.0 mm diameter, which increases at the marginal collar, resulting in a coronal diameter 5.0 mm. Both fixtures have Microthread™ at their coronal collar and a fluoride-modified TiO-blast surface.[9]

2. Methods

1) Treatment procedure

The two fixture types were installed adjacent to each other at the same edentulous area in randomized order. All implants were installed using the two-stage submerged surgical technique described. A second surgery was performed after a healing period of 3 months in the mandible and 6 months in the maxilla. Three weeks after the second surgery, the prostheses were delivered. Patients were recalled every 3 months after prosthesis delivery, and clinical examination, professional plaque control, and oral hygiene instruction were performed at every visit.

2) Radiographic examination

One day after the first surgery, second surgery, prosthesis delivery, and 1 year after functional loading, a periapical radiograph (Kodak Insight, film speed F, Rochester, NY, USA) was taken (70 KVp, 10mA, Yoshida REX 601, Tokyo, Japan) (Fig.1).[10] The parallel cone technique with an XCP device (XCP Kit, Ran, Elgin, IL, USA) was used. A 5.5 mm spherical metal bearing was placed on the XCP bite block as a reference diameter for the bone level measurements. Films were developed using the same automatic processor

(Periomat, Dürr Dental, Bietigheim-Bissingen, Germany) following the manufacturer’s manual.

All radiographs were scanned (EPSON GT-12000, EPSON, Nagano, Japan) at 2400 dpi with 256 gray scale. After digitization, the files were transferred to a personal computer (Processor, Intel Celeron D, Santa Clara, CA, USA; Windows XP Professional 2002 operating system, Redmond, WA, USA) and radiographic measurements were taken in the dark using the same monitor (Flatron 775FT Plus, LG, Seoul, Korea, 1024 × 768 pixel resolution).[11]

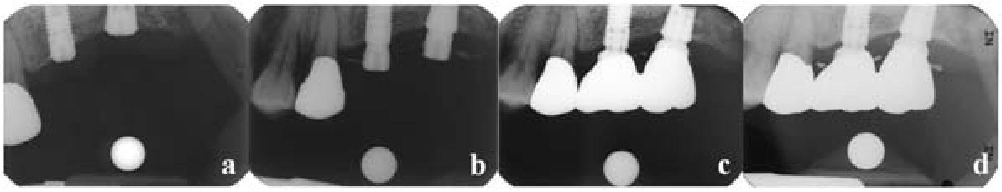

Figure 1. Intra-oral radiographs of implants

(a, 1^{st}surgery; b, 2^{nd}surgery; c, Prosthesis delivery; d, 1-year follow-up)

3) Measurement of marginal bone level change

The marginal bone level was measured from the reference point to the lowest observed contact point of the marginal bone and implant fixture. The border between the machine surface and TiO-blasted surface was considered as the reference point (Fig. 2). Calibration was performed with a spherical metal bearing of known diameter (5.5 mm). UTHSCSA Image Tool (Version 3.00, The University of Texas Health Science Center in San Antonio) was used to measure the distance from the reference point to the marginal bone level to the nearest 0.01 mm. The bone level of each fixture was measured on both the mesial and distal sides, and the average value was used. In the case of bone gain, the amount of bone loss was considered zero.

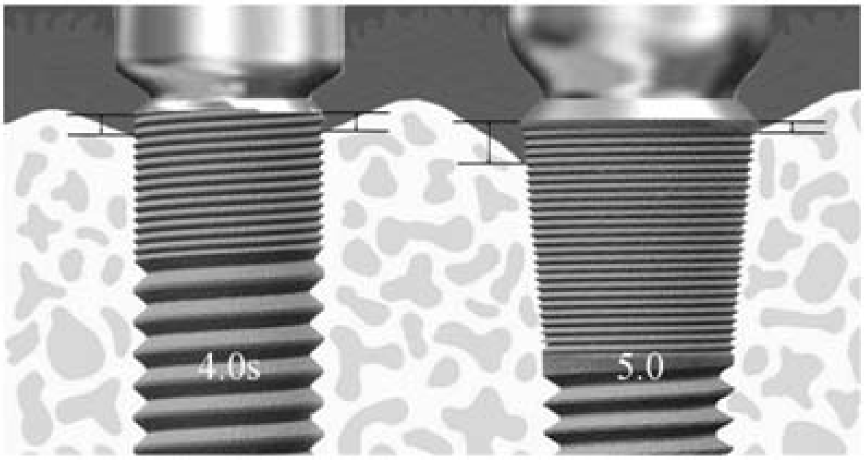

Figure 2. Schematic presentation of measurements of site and reference point (4.0s, Astra Tech Osseospeed™ 4.0S implant; 5.0, Astra Tech Osseospeed™ 5.0 implant)

4) Follow-up parameters

At the 1-year follow-up, the presence/absence of pain, discomfort, or infection associated with the implants were recorded. The clinical immobility of each implant was also checked after bridge removal. A surviving implant was defined as an implant that was stable, functional, and symptom-free. To investigate the influence of inflammatory changes of the peri-implant tissues on the surrounding marginal bone, the modified plaque index (mPI) and modified mucosal index (mMI)[10] were measured at four aspects around the each implant. The average of the four obtained mPI and mMI values was calculated to represent the respective values for each implant.

5) Statistical analysis

The null hypothesis was that there would be no difference between the marginal bone loss of 4.0s and 5.0 during the examination period. The Wilcoxon's signed-rank test the significance of differences in the marginal bone loss between the two groups. A computer software (SPSS for Windows Release 13.0, SPSS Inc., Chicago, IL, USA) was used to process the data. The value was deemed statistically significant if the p-value was lower than 0.01. The value was deemed significant if the *p*-valuewas<0.01.

III. Results

1. Clinical examination

During the observation period, no remarkable complications were found. No patient suffered from pain or implant mobility, and no prosthetic complications were observed.

2. Marginal bone-level changes

The marginal bone loss for each implant is illustrated in Table 1. The mean marginal bone losses (4.0s, 0.058 ± 0.096mm; 5.0, 0.067 ± 0.152mm) were not statistically significant between the two groups.

3. Evaluation of peri-implants soft tissue

The peri-implant soft tissues revealed little tendency to bleed following probing and were clinically healthy. The average mPI of the 4.0s group was 0.80 and of the 5.0 group was 0.73. The average mMI of the 4.0s group was 0.50 and of the 5.0 group was 0.57. No statistically significant differences were found between the two groups for either index.

Table 1. Marginal bone loss of 4.0s and 5.0 implants

Subject	***Type of Implants***	
	4.0s	**5.0**
1	0.025	0
2	0.31	0.47
3	0	0
4	0	0
5	0.065	0
6	0	0
7	0	0
8	0.085	0
9	0.1	0.185
10	0	0.015
Mean	0.058	0.067
Median	0	0.125
Standard deviation	0.0966	0.1529
P-value	0.833*	

4.0s, Astra Tech Osseospeed™ 4.0s implant; 5.0, Astra Tech Osseospeed™ 5.0 implant Level of significance (*P<0.01)

IV. Discussion

The The purpose of the present study was to evaluate the effect of conical neck design with Microthread™ on the marginal bone level at the fixture, comparing the amount of marginal bone loss between two implant types installed adjacent to each other. The implant fixtures used in present study had the same surface treatment (Osseospeed™), implant-abutment interface (Conical Seal Design™), and thread characteristics, so that all possible effects of implant design except the gross shape could be minimized. Lee et al. suggested that aligning fixtures of different types and connecting them facilitates the matching of the individual load to each tested fixture.[7] In the present study, each implant type was aligned adjacent to and connected with the other in the same edentulous area to minimize the effects of variables such as load and bone quality. To minimize the possible effects of plaque, repeated professional plaque control and oral hygiene instruction were performed throughout the examination period.

In present In present study, the mean marginal bone losses were 0.058 ± 0.097 mm(4.0s group) and 0.067 ± 0.152 mm (5.0 group). In the 5.0 group (conical neck designed implants), the amount of peri-implant marginal bone loss was much smaller than that observed in some previous studies,[3,4] but consistent with the results of others.[5,7] Because the implants used in Qurynen et al. and Malevez et al. had a flat top interface and machined conical surface,[3,4] differences from our results might be due to differences in the implant-abutment interface, surface topography, and/or the use of Microthread™. Indeed, the Microthread™ on the neck portion might be considered as the major contributor to the observed differences.[13]

The Hansson concluded that the conical interface transfer the load deeper into the bone, thus reducing the peak stress at the peri-implant marginal bone compared to a flat top interface.[14,15] The results of some clinical studies indicate that the conical seal design offers advantages in the marginal bone level maintenance.[16-18] With retention elements at the implant neck, the marginal bone is reportedly stimulated mechanically by axial loads on the implant, and retention elements such as a rough surface and Microthread™ at the neck portion help maintain the marginal bone level.[8] Finite element analyses indicate that threads of small dimensions are quite effective at preserving the marginal bone.[19] Finally, experimental studies have verified the advantages of Microthread™ compared with a smooth neck, in terms of established bone-to-implant contact and marginal bone level maintenance.[20-22]

Misch and Bidez Misch and Bidez claim that an angled crest module of more than 20 degrees with a surface texture that increases bone contact might impose slightly beneficial compressive and tensile components to the contiguous bone and decrease bone loss risk.[23] Because the conical neck design transmits the compressive forces to the bone, this could help maintain the marginal bone level.[24] Using a three-dimensional finite element analysis, Huang et al. demonstrated that the tapered body reduces stresses in both the cortical and trabecular bone, potentially due to the increased interfacial area.[6] Also, Kong et al. proposed that the taper of the implant neck favors stress distribution in the cortical bone and affects implant stability.[25]

In present study, we found no significant difference between conical and straight necked implants in terms of marginal bone loss. It is possible that the effects of the conical implant-abutment interface, Microthread™ and rough surface on marginal bone level maintenance compensated for the effects of conical neck design. However, because the present study had some limitations, such as small sample size and possible false diagnosis in analyzing small peri-implant bone-level changes, further research is needed to clarify the mechanism and the relationship between implant design and crestal bone loss.

V. Conclusion

The aim of the present prospective clinical study was to evaluate the effect of the conical neck design with Microthread™ on the marginal bone level of the fixture by comparing the amount of marginal bone loss between the Astra Osseospeed™ 4.0s and 5.0 implant types.

The the mean marginal bone losses were 0.058 ± 0.097 mm(4.0s group) and 0.067 ± 0.152 mm (5.0 group), and not statistically significant between the two groups (p=0.833).

According to the present study, the effects of the conical implant-abutment interface, Microthread™ and rough surface on marginal bone level maintenance might compensate for the effects of conical neck design.

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국문 요약

서로 다른 임플란트 경부 디자인을 갖는 임플란트 주위 변연골의 전형적 비교 분석 : 원뿔형 대 원통형 디자인

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이번 연구의 목적은 서로 다른 형태를 갖는 두 가지 임플란트를 인접하여 식립하여 임플란트 주위골 소실량을 비교함으로써, 원뿔형의 치관측 디자인이 임플란트 주위 변연골 소실에 어떠한 영향을 미치는지를 평가하는 것이다.

총 10명의 환자에게 임플란트 매식체의 치관측 형태가 원뿔형인 매식체(5.0)와 원통형(4인 매식체(4.0s)를 인접하여 식립하였다. 상부 보철물 연결시의 방사선 사진과 기능적 부하를 가하고 1년 후의 방사선 사진 사이의 임플란트 주위 변연골 흡수량을 비교하여 임플란트 매식체의 치관측 형태에 따른 골흡수량을 비교 분석하였고, 임플란트에서 변연골에 미치는 염증의 영향을 조사하기 위해 기능적 부하를 가하고 1년 후 각각의 임플란트에서 치은 지수 (치태 지수, 점막 지수) 를 측정하였다.

각 임플란트의 골흡수량의 평균은 4.0s 임플란트는 0.058mm ± 0.096, 5.0 임플란트는 0.067mm ± 0.152였으며, Wilcoxon's signed-rank test를 이용하여 분석한 결과, 통계학적으로 유의할 만한 차이를 보이지 않았다.(*p*=0.833). 기능적 부하를 가하고 1년 후 측정한 치은 지수 (치태 지수, 점막 지수)는 두 임플란트에서 유의한 차이를 보이지 않았다 (치태지수; *p*=0.4973, 점막지수; *p*=0.4609).

본 연구 결과에 의하면 임플란트 매식체의 치관측 형태는 임플란트 주위 변연골의 유지에 있어서 중요한 요소로 작용하지 않는다고 할 수 있다. 그러나 임플란트 디자인과 변연골 흡수와의 관계와 그 기전을 명확하기 위해 더 많은 연구가 필요하다.

핵심되는 말: 임플란트 디자인, 변연골 소실량, 전향적 연구