Case Series

Dimension of Interproximal Soft Tissue Between Adjacent Implants in Two Distinctive Implant Systems

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Background: *The purpose of this study was to compare the dimension of interproximal soft tissue between adjacent implants in distinctive implant systems.*

Methods: *This study involved 85 interproximal papillae between two adjacent implants in 50 patients who had implants placed adjacent to each other and who had prosthesis in place for longer than 1 year. The shortest distance between the radiopaque material on the tip of interimplant papilla and the most coronal portion of the interimplant crestal bone was measured (radiographic length of papilla [RL]). The horizontal distance (HD) between the two adjacent implants was measured at the fixture-abutment interface level. Considering the possible effect of interimplant crestal bone resorption on closely implanted sites, HDs were divided into two categories: HD <3 and ≥3 mm. The Mann-Whitney test was performed to find the difference in the dimension of interimplant papilla.*

Results: *In cases of HD <3 mm, RL did not differ statistically in both systems. Also, in cases of HD >3 mm, RL did not show a statistically significant difference in both systems.*

Conclusion: *Both systems had similar dimensions of interproximal soft tissue between adjacent implants, irrespective of the horizontal distance of the fixture.* J Periodontol 2006;77:1080-1084.

KEY WORDS

Dental esthetics; dental implants; dental papilla/anatomy and histology; gingiva/anatomy and histology; tissues/anatomy and histology.

Understanding the topography and dimension of the soft tissue around dental implants is critical in implant dentistry. The possible difference with respect to alveolar bone level and soft tissue dimension in different implant systems has been investigated in an animal study,[1] which demonstrated similar degrees of bone level and vertical dimension of soft tissue around implant systems A‡ and B.§ However, statistically significant differences in the area of infiltrated connective tissue (ICT) were noted among the peri-implant mucositis-induced models.[2] Thus, system A showed a smaller area of infiltrated connective tissue (ICT) compared to system B. To our knowledge, the clinical significance of this finding has not yet been investigated.

The marginal bone level and soft tissue condition in systems A and B were further compared in a later human study.[3-5] However, parameters focusing on interproximal papilla were not included.

The purpose of the present investigation was to compare the dimensions of interproximal soft tissue between adjacent implants in systems A and B.

MATERIALS AND METHODS

Participants

The present study was based on 50 patients (29 men and 21 women) aged 42 to 60 years (mean age, 51.4 years) who had implant-supported, fixed prosthesis in posterior sites for longer than 12 months. The patients had implant surgery and prosthetic treatment at the Department of Periodontology of the Yongdong Severance Hospital from January 2000 to February 2002, and participants were recruited for radiographs and clinical examinations from January 2003 to February 2004.

All of the patients had undergone specific oral hygiene instruction for the individual implant prosthesis right after delivery, using interproximal brushes of various sizes. Subjects who were taking any medication

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‡ Astra-Tech implant, Fixture TiOblast, Astra-Tech, Mölndal, Sweden.
§ Brånemark system implant, MK II and MK III, Nobel Biocare, Göteborg, Sweden.

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known to affect the periodontal soft tissues or who had any kind of soft tissue graft during implant surgery were excluded. The study protocol was approved by the Yonsei University Ethics Committee. Informed consent was obtained from all subjects.

Treatment Procedures

A two-stage technique was used for placement of both implant systems. Selection of the implant system, A or B, was randomly assigned. After a healing period of 3 months in the mandible and 6 months in the maxilla, a second surgery was performed. Two weeks after second surgery, an impression was taken at fixture level. Abutments were selected and milled at the laboratory. Abutments were cleaned in an ultrasonic bath and autoclaved before delivery. During waxing of bridges, the width of the embrasures was matched to the size of the interdental cleaning device recommended to the patients.[6] Three weeks after the second surgery, prosthesis was delivered. The prosthesis was cement-retained by temporary cement.[‖] The patients were recalled every 6 months for thorough professional plaque control and repeated oral hygiene education. In total, 24 patients received system A, and 26 patients received system B.

Clinical Examination

At a minimum of 1 year after prosthesis delivery, clinical examination was performed.[3] Thus, bleeding on probing (yes or no; on buccal, lingual, mesial, and distal sites), presence of plaque (yes or no; on buccal, lingual, mesial, and distal sites), mobility (without suprastructure removed), and width of keratinized mucosa (WK) at interproximal papilla area between adjacent implants were examined. Probes[¶] calibrated at 1, 2, 3, 5, 7, and 10 mm were used to measure the width of keratinized mucosa from the mucogingival junction to the tip of interproximal papilla between adjacent implants to the nearest 0.5 mm (WK), which was known to have a close positive relation with the dimension of interproximal soft tissue between adjacent implants.[7] The mucogingival border was identified, if in doubt, by inspecting mucosal surface characteristics functionally by applying a periodontal probe to the alveolar mucosa parallel to the border, thereby demarcating the mucogingival junction.[8] Patients who had inflamed mucosa around implants with bleeding tendency and plaque accumulation were excluded and rejected. Rejected patients were reinstructed on proper oral hygiene and reexamined during another session.

Radiographs

Measuring the dimension of interproximal soft tissue between adjacent implants (radiographic length of papilla [RL]) was performed on periapical radiographs. A schematic illustration of the measured distance is depicted in Figure 1, and representative periapical radiographs are shown in Figure 2. Measurement of the radiographic length of papilla using a radiopaque material is described elsewhere.[7,9] In brief, a radiopaque material consisting of a 2:1 mixture of an endodontic sealer[#] and barium sulfate[**] was placed with a probe on the tip of the papilla. A periapical radiograph[††] was taken (70 KVp, 10 mA[‡‡]) using a parallel cone technique with an extension cone paralleling (XCP)[§§] device.[10] All films were developed using the same automatic processor[‖‖] following the manufacturer's instructions. The radiographs were digitized using a computerized scanner[¶¶] at 600 dpi and 256 gray scale.

After digitization, all files were transferred to a personal computer[##] and examined using the same monitor,[***] which was set to a resolution of 1,024 × 768

Figure 1.
Schematic illustration of measured distance. RL = distance from the tip of papilla to the crestal bone (radiographic length of papilla); WK = distance from the tip of papilla to the mucogingival junction (width of keratinized mucosa); HD = horizontal distance between two adjacent implants (horizontal distance); MGJ = mucogingival junction.

‖ Temp-Bond, Kerr, Orange, CA.
¶ Williams PW, Hu-Friedy, Chicago, IL.
# Tubli-Seal, Kerr.
** Solotop suspension 140, TAEJOON Pharm, Seoul, Korea.
†† Kodak Insight, film speed F, Kodak, Rochester, NY.
‡‡ Yoshida REX 601, Yoshida, Tokyo, Japan.
§§ Rinn XCP, DENTSPLY Rinn, Elgin, IL.
‖‖ Periomat, Durr Dental, Bietigheim-Bissingen, Germany.
¶¶ Epson GT-12000, Epson, Nagano, Japan.
Processor, Intel Pentium 2.4 GHz, Intel, Santa Clara, CA; operating system, Windows 2000, Redmond, WA.
*** Flatron LCD, LG, Seoul, Korea.

pixels. During the computer-assisted radiographic measurements, the room was darkened. To calculate the length between the crestal bone and the tip of papilla, a line was drawn connecting the abutment-fixture junction between two implants and two parallel lines were drawn passing the tip of the papilla and the tip of the crestal bone. The shortest distance between two lines, that is, the length between the most coronal portion of the interimplant crestal bone to the radiopaque material, was measured to the nearest 0.01 mm with an imaging tool.††† Along with measuring papilla, the distance between two adjacent implants (horizontal distance [HD]) was measured at the same periapical radiograph at the fixture-abutment level. Calibration was done with known thread pitch distance for vertical measurement and fixture diameter for horizontal measurement.

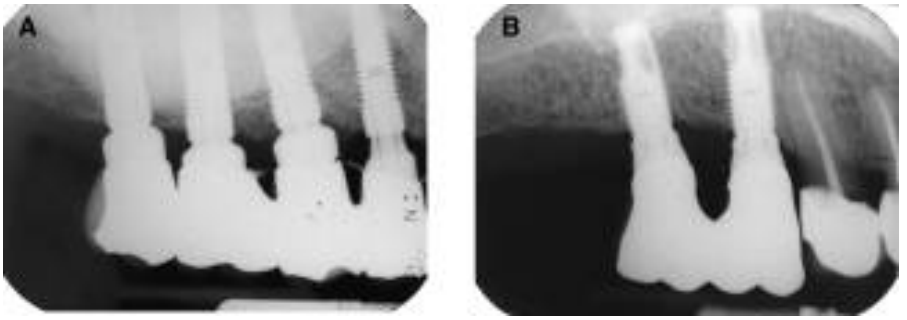

Figure 2.
*Periapical radiographs of system A **(A)** and system B **(B)** with radiopaque material on the tip of the interproximal soft tissue between the implants.*

Statistical Analysis

Considering the possible effect of interimplant crestal bone resorption on closely implanted sites, data were divided into four categories:[11] system A with HD <3 mm (N = 21) (category 1) and HD ≥3 (N = 22) (category 2) and system B with HD <3 mm (N = 20) (category 3) and HD ≥3 (N = 22) (category 4). The Mann-Whitney test was performed to find the differences in the dimension of interproximal soft tissue between adjacent implants, differences in frequency of bleeding on probing and plaque accumulation, differences in the width of keratinized mucosa from the mucogingival junction to the tip of interproximal papilla, and differences of the HD between categories 1 and 3 and categories 2 and 4. All calculations were performed on a personal computer with a program for statistics.‡‡‡

RESULTS

Clinical Examination

No remarkable complications were found during the observation period. No patients reported experiencing pain or mobility on implants. Also, there were no suprastructural complications.

As patients were rejected and reexamined in cases of harboring plaque and detection of bleeding on probing, patients participating in the present study showed low frequency of plaque accumulation (0% to 1%) and bleeding on probing (0%), which was not statistically different between the two implant systems.

The mean ± SD of the width of keratinized mucosa from the mucogingival junction to the tip of interproximal papilla between adjacent implants was 4.4 ± 1.2 mm in group A and 4.1 ± 0.9 mm in group B, which showed no statistical difference.

In cases of HD <3 mm, RL was 3.20 ± 0.4 mm and 2.92 ± 0.6 mm, respectively, in groups A and B, which did not differ statistically. The mean HD was 2.68 ± 0.6 mm in group A and 2.75 ± 0.3 mm in group B, which showed no statistical difference. Also, in cases of HD >3 mm, RL was 3.02 ± 0.5 mm and 3.21 ± 0.3 mm in groups A and B, respectively, which did not show a statistically significant difference. The mean HD was 3.62 ± 0.9 mm in group A and 3.78 ± 1.2 mm in group B, which showed no statistical difference (Table 1).

Table 1.

Various Parameters (mean ± SD [mm])

	RL				
	System A		System B		
Horizontal Distance	N*	Mean (SD)	N*	Mean (SD)	*P* Value
<3 mm	21	3.20 (0.4)	20	2.92 (0.6)	0.21
≥3 mm	22	3.02 (0.5)	22	3.21 (0.3)	0.11

* Number of examined papilla.

DISCUSSION

Dimension of interproximal soft tissue between adjacent implants was investigated in various implant systems.[7,12] Similar results reported that the mean height of soft tissue was 3.3 to 3.4 mm. However, dimensional differences in interproximal soft tissue among implant systems with distinctive features were not addressed. The implant systems used in the present study were frequently compared with respect to alveolar bone loss and soft tissue dimension.[3-5] Yet,

††† Version 3.00, The University of Texas Health Science Center in San Antonio, San Antonio, TX.
‡‡‡ SPSS for Windows release 12.0, SPSS, Chicago, IL.

again, dimensions of interproximal soft tissue between implants were not compared.

In an animal study comparing systems A and B,[2] the only statistically significant difference was found in the area of plaque-associated ICT among the peri-implant mucositis-induced model (0.25 mm^2 for system A and 0.32 mm^2 for system B). In the same experiment, although no statistical comparison was performed, a larger area of abutment-associated infiltrated connective tissue (a-ICT) was reported on system B (0.05 mm^2 for system A and 0.08 mm^2 for system B). In another animal study, it was speculated that a-ICT played a role in the protective mechanism of the host to prevent further deterioration of the implant.[13] Also, in the same experiment, the development of a-ICT was found to be unrelated to the presence of plaque at the border of peri-implant mucosa. Thus, the subjects of the present study could have possibly harbored abutment-associated infiltrated connective tissue, irrespective of the carefully maintained oral hygiene status in both groups. The clinical significance of amount of a-ICT has not yet been investigated. However, it is probable that it would play a minor role in determining a dimensional difference because the area occupied by the a-ICT is relatively small.

Recently, tissue reaction to abutment shift was examined in an animal study[14] comparing soft tissue reaction to permanent abutments (ethylene oxide sterilized) and prepped abutments (autoclaved after milling). The histometric measurement showed that the peri-implant mucosa of prepped abutments showed higher height/area of the a-ICT, probably due to the direct communication between the oral cavity and the connective tissue of the peri-implant mucosa than that of the permanent abutments. However, a similar dimension of peri-implant mucosa (from mucosal margin to the alveolar bone) was found among permanent abutments and prepped abutments, implying a minor role of a-ICT in determining the total dimension of peri-implant mucosa.

Thus, a possible soft-tissue dimensional difference among systems with distinctive features would be less plausible in that different dimensional features of the fixture-abutment junction or different abutment material may not give rise to dimensional changes on the peri-implant mucosa.

The regeneration of interproximal papillae after single implant treatment, that is, increase in dimension of interproximal papilla between single implant and natural dentition, was reported using system B.[15] The author stated that recovery of papillae was possibly due to the plaque accumulation in the proximal areas, resulting in maturation of the papillae. Thus, plaque accumulation and regeneration of interproximal papilla were addressed. It was carefully proposed that use of interproximal brushes right after prosthetic delivery could counteract a regeneration of the soft tissue contour. However, in the present study, use of an interproximal brush was recommended and strictly observed during recall. This might have compromised regeneration of interproximal soft tissue creeping. Nevertheless, the optimal hygiene of the implant prosthesis had priority over possible esthetic results.

The relationship between the dimension of interproximal soft tissue between adjacent implants and various parameters (i.e., width of keratinized mucosa, horizontal distance between implants, and distance between the base of contact point and the crestal bone) was investigated.[7] However, the width of keratinized mucosa was the sole parameter that showed a significant positive relationship with the dimension of interproximal soft tissue between adjacent implants. The authors speculated that the width of keratinized mucosa could be related to the phenotype of the mucosa around implants; thus, the dimension of interproximal soft tissue between adjacent implants might be related to the gingival phenotype of preexisting or contralateral natural dentition. In that context, the width of keratinized mucosa around different systems was compared in the present study, showing no significant difference among the systems.

The difficulty of measuring the dimension of interproximal soft tissue between adjacent implants in a clinical setting lies in the invasiveness of the previously used technique, for example, bone probing under administration of local anesthesia, and the difficulty in exactly measuring the distance between the papilla tip and the top of crestal bone without removing the prosthesis in cases of cement-retained prostheses. These predicaments were overcome by applying non-invasive techniques using radiopaque material.[9]

One drawback of the present study might be the small number of participating patients. Also, the period of clinical examination was 12 months after prosthesis delivery, which could be a relatively short time for maturation of the peri-implant soft tissue. Enrollment of a larger population and long-term follow-ups after prosthesis delivery are necessary to confirm the present findings.

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