Statistical Analysis of the Diachronic Loss of Interproximal Contact Between Fixed Implant Prostheses and Adjacent Teeth

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Purpose: The aim of this study was to clarify the aspects of loss of interproximal contact (IC) between fixed implant prostheses and the adjacent teeth. ***Materials and Methods:*** A total of 146 implant prostheses in 105 patients were investigated. The loss of IC between fixed implant prostheses and adjacent teeth was evaluated using a 50-μm-thick contact gauge, and the IC was regarded as lost when the gauge was inserted into an IC without resistance at follow-up visits. Statistical analyses were performed to clarify the IC loss rate and factors affecting it. ***Results:*** Eighty of 186 ICs (43%) were regarded as lost. The IC loss rate at the mesial aspect was significantly greater than that at the distal aspect ($P = .000$, Wilcoxon test). Age, the condition of the opposing dentition, the vitality of the adjacent teeth, and the state of splinting of the adjacent teeth affected the loss of IC at the mesial aspect significantly ($P < .05$, Cox regression analysis). ***Conclusion:*** Loss of IC between fixed implant prostheses and adjacent teeth was observed frequently at follow-up visits, especially at the mesial aspects of the prostheses. It is considered that this phenomenon may induce food impaction and cause an adverse effect on the peri-implant tissue. Hence, appropriate informed consent and careful maintenance at follow-up visits regarding IC between implants and adjacent teeth are important, and the loss of IC should be recovered if observed. *Int J Prosthodont 2010;23:535–540.*

Osseointegrated dental implants have been successfully used to restore completely and partially edentulous patients for more than 35 years, and an excellent success rate of 95% or higher has been reported.[1–3] Moreover, definitive contraindications for implant therapy have been reduced. On the other hand, many complications associated with dental implants, such as implant loss, surgical complications, marginal bone changes, peri-implant soft tissue problems, and mechanical troubles, have been documented extensively.[4–7] With regard to mechanical implant complications, screw loosening and fractures, implant fractures, framework fractures, resin base and veneering material fractures, fractures of an opposing prosthesis, and mechanical retention problems of the overdenture have been reported.[8]

The loss of interproximal contact (IC) between fixed implant prostheses and adjacent teeth is often observed in daily clinical practice.[9,10] Patients with implant prostheses sometimes complain of food impaction at the implant site. This phenomenon is considered a common complication associated with osseointegrated dental implants. However, there are no reports on the loss of IC to date, even though it may have an adverse effect on the peri-implant structures. Hence, the purpose of this clinical investigation was to evaluate the IC loss rate between fixed implant prostheses and adjacent teeth and to clarify the factors affecting it.

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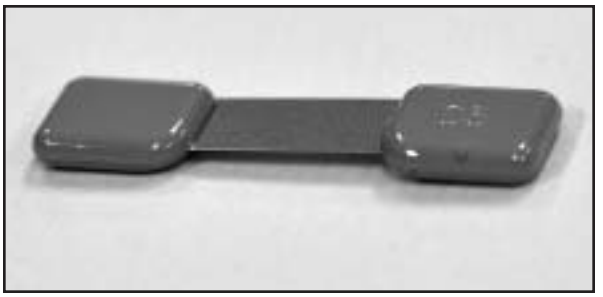

Fig 1 Contact gauge used in the present study. The metal strip was 50-μm thick.

Materials and Methods

Selection of Study Sample

One hundred fourteen patients who visited a private practice for implant maintenance between January 1999 and April 2007 participated in the present study. Patients suffering from serious systemic disease were excluded. Study samples were selected based on the following selection criteria: natural adjacent teeth and adjacent fixed partial dentures delivered on natural teeth, implant prostheses supported by only implants, endosseous root form implants used, and IC properly adjusted to a thickness of 50 μm at prosthesis delivery. Exclusion criteria included: implant prostheses connected to natural teeth, implant-supported prostheses adjacent to implant prostheses, implant prostheses supported by implants other than endosseous root form implants, and IC appropriately restored at least once after prostheses delivery.

In accordance with the selection criteria, 105 patients (38 men, 67 women) between 20 and 78 years of age with 353 implants (91 in the maxilla, 262 in the mandible) were recruited. The total number of implant prostheses was 146, and the period after insertion ranged from 1 to 123 months.

This clinical research was approved by the ethical committee at Kyushu University, Fukuoka, Japan (permission no. 20-24).

Implants and Prostheses

The implant systems used in the study samples were Replace (Nobel Biocare), Steri-Oss (Nobel Biocare), Straumann (Straumann), Integral (Calcitec), Brånemark System (Nobel Biocare), and IMZ (Friedrichsfeld), in order of frequency of use. The implant forms were screw or cylinder type. Most implants were placed in a healed site; a few were placed immediately after tooth extraction. The definitive implant prostheses were single crowns, two to four splinted crowns supported by two to four implants, or three- to six-unit fixed partial dentures supported by two to four implants, which consisted of all-ceramic crowns, porcelain-fused-to-metal crowns, hybrid resin–faced metal crowns, or full-cast metal crowns. Definitive restorations were inserted with the appropriate adjustment by a prosthodontic specialist certified by the Japan Prosthodontic Society 3 to 6 months after implant placement.

Adjacent and Opposing Teeth

Adjacent teeth consisted of natural teeth, single crowns, 2- to 6-unit splinted crowns, and 3- to 8-unit fixed partial dentures. Opposing teeth were natural teeth, single crowns, splinted crowns, 3- to 14-unit fixed partial dentures, implant prostheses, removable partial dentures, or removable complete dentures. The state of the adjacent and opposing teeth exhibited no major changes during the observation period, except for the composite resin restoration in the cervical area of several natural teeth.

Measurement

A contact gauge (GC) with a 50-μm-thick metal strip was used to measure IC between implant prostheses and adjacent teeth (Fig 1). If the gauge could be inserted into an IC area with moderate resistance, the tightness of the IC was regarded as "adequate"; it was regarded as "lost" if the gauge could be inserted without resistance (Fig 2).

IC measurements were conducted every 6 months at regular follow-up visits, although measurements were done every 1 to 3 months for some patients. For posterior and anterior bounded patients, two ICs were registered. All ICs were evaluated by a prosthodontic specialist certified by the Japan Prosthodontic Society.

Along with the tightness of the IC area, age, sex, the state of the opposing teeth, the region of prosthesis insertion, the number of implants, the state of splinting of the adjacent teeth, the vitality of the adjacent teeth, and the number of days after delivering the prosthesis were recorded.

Fig 2 **(a)** Intraoral view and **(b)** radiograph of a patient who exhibited IC loss between a fixed implant prosthesis and the adjacent teeth 1 year after delivery of the prosthesis in the maxillary right second premolar and first molar region. Two implants were splinted by the implant prosthesis. The first premolar was a natural tooth restored with a composite resin–faced crown. The loss of IC between the first and second premolar (implant-supported prosthesis) was confirmed with the insertion of 50-μm-thick contact gauge without any resistance.

Statistical Analysis

The IC loss rate was calculated and compared at two aspects (mesial and distal) and two regions (maxilla and mandible) (Wilcoxon test). Chronologic change in the IC loss rate was analyzed using the Kaplan-Meier method; chronologic changes between mesial and distal aspects were compared using the log-rank test. Factors affecting the IC loss rate were examined by Cox regression analysis. SPSS 17.0J (SPSS) was used for the statistical analysis, and the level of significance was set at $P < .05$.

Results

IC Loss Rate

The total number of IC areas between prostheses and adjacent teeth obtained through the sample selection was 186; 80 (43%) were regarded as lost. The IC loss rate at the mesial and distal aspects of the prostheses was 51.8% and 15.6%, respectively (Table 1), with the mesial aspect loss significantly greater than that at the distal aspect ($P = .000$, Wilcoxon test). The rate in the mandible was significantly greater than that in the maxilla ($P = .023$, Wilcoxon test).

Chronologic changes in the loss rate are shown in Fig 3; it increased over time. The pooled data revealed that half of the IC areas might be lost in 5.5 years. The curve of the time change for the loss of IC at the mesial aspect was significantly steeper than that at the distal aspect ($P = .008$, log-rank test).

Table 1 IC Loss Rate According to Aspect and Region

	Maxilla	Mandible	Total
Mesial	16/36 (44.4%)	57/105 (54.3%)	73/141 (51.8%)
Distal	5/30 (16.7%)	2/15 (13.3%)	7/45 (15.6%)
Total	21/66 (31.8%)	59/120 (49.2%)	80/186 (43.0%)

IC = interproximal contact.

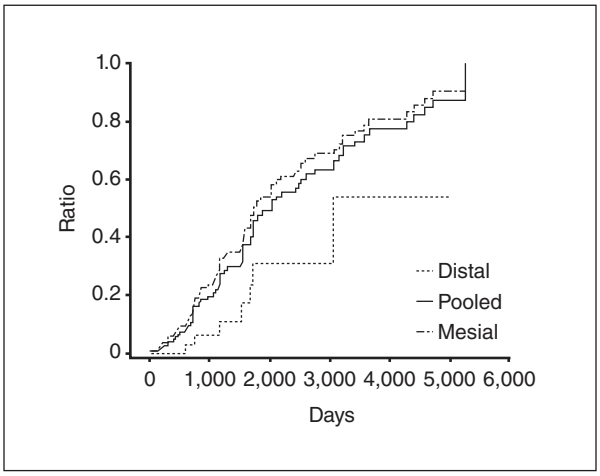

Fig 3 Chronologic changes in the rate of IC loss calculated using the Kaplan-Meier method. The horizontal axis shows the days after delivering the fixed implant prostheses; the vertical axis shows the IC loss rate.

Table 2 Risk Ratio in Relation to Loss of IC at the Mesial Aspect of Implant Prostheses

Factor/condition	Risk ratio (95% CI)	*P*
Age		
N [20 ≤ N ≤ 77]	1	
N + 1	1.031 (1.000–1.062)	.047**
Sex		
Male	1	
Female	1.132 (0.660–1.944)	.652
State of opposing dentition		
Natural teeth or implants	1	
Removable partial denture	0.381 (0.161–0.898)	.027**
State of teeth lost restored with implants		
Bounded	1	
Free-end	1.276 (0.572–2.848)	.552
State of vitality in adjacent teeth		
Vital	1	
Nonvital	1.825 (1.011–3.295)	.046**
State of splinting in adjacent teeth		
Nonsplinted	1	
Splinted	0.460 (0.256–0.825)	.009*
Region of implant prostheses		
Anterior	1	
Premolar	0.978 (0.267–3.587)	.978
Molar	0.660 (0.326–1.336)	.249
Arch		
Maxilla	1	
Mandible	0.721 (0.356–1.460)	.364
No. of implants		
N [1 ≤ N ≤ 3]	1	
N + 1	1.308 (0.889–1.925)	.269

IC = interproximal contact; CI = confidence interval.
*P < .01; **P < .05 (Cox regression analysis, N = 141).

Factors Affecting Loss of IC

Cox regression analysis revealed that age, the state of the opposing dentition, the vitality of the adjacent teeth, and splinting of the adjacent teeth affected the loss of IC at the mesial aspect of the prostheses significantly (Table 2). On the other hand, there were no factors that significantly affected the loss of IC at the distal aspect of the prostheses.

Discussion

The present study is the first report in which the loss of IC between implant prostheses and adjacent teeth was investigated statistically in a clinical situation. It was surprising that the overall IC loss rate was 43% in the study sample even though the period after prostheses delivery was not controlled systematically. It was also revealed that the loss of IC would increase over time.

There are several reports on the loss of IC between natural teeth. Pilcher and Gellin[11] reported that radiographic scanning showed progressive bone loss in a tooth restored via cast restoration with an open proximal contact area for more than 7 years. Hancock et al[12] reported significant relationships between food impaction and contact type determined by the insertion of dental floss and between food impaction and pocket depth. These findings reinforced the clinical observation that food impaction contributes to periodontal problems. Jernberg et al[13] investigated the periodontal status of teeth with unilateral open contacts in 104 adult subjects and reported that an increasing probing depth and attachment loss were found at proximal tooth open contacts. It is well understood that the loss of proximal contact between natural teeth could have adverse effects on the periodontal tissue, as previously described. This assumption could also be applied to the IC area between fixed implant prostheses and adjacent teeth. Moreover, care should be taken since peri-implant tissue is considered to be more susceptible to damage than the periodontal tissue of natural teeth.[14,15]

It was shown clearly that IC at the mesial aspect was more likely to be lost than at the distal aspect. It was also revealed that the loss of IC was more frequent in the mandible than in the maxilla. Dörfer et al[16] reported that the strength of proximal contact can be significantly influenced by location, tooth type, chewing, and time of day in complete natural dentitions, and it was presumed that the position of natural teeth might not be stable in the arch. On the other hand, it is generally understood that titanium dental implants are ankyloses within the bone.[17–20] Roberts et al[21] revealed that continuously loaded implants remained in a stable position within the jaw bone of rabbits. Hence, it can be considered that the more frequent loss of IC at the mesial aspect may be explained by the mesial migration of the adjacent teeth.[9] It may be difficult to prevent an increase in the loss of IC over time because of the difference in the connection within the bone between implants and natural teeth.

Although the univariate analysis using the Wilcoxon test showed that the loss of IC was more frequent

in the mandible than in the maxilla, the multivariate analysis using Cox regression revealed that the factor "arch" did not influence IC loss at the mesial aspect significantly. This may be due to the difference in the distribution of IC areas between the maxilla and mandible (36 of 66 and 105 of 120 were mesial IC areas lost, respectively). Namely, the predominant distribution of mesial IC areas lost in the mandible could result in the more frequent IC loss compared with the maxilla.

Among the factors investigated, age, the state of the opposing dentition, the vitality of the adjacent teeth, and the state of splinting of the adjacent teeth affected the loss of IC at the mesial aspect of implant prostheses significantly. The loss of IC could increase by a factor of 1.031 with the increment of age and increase 1.825 times when the adjacent teeth are nonvital. However, the lower sides of the confidence limit of the risk ratios for age and the vitality of adjacent teeth were 1.000 and 1.011, respectively. Accordingly, these two factors may not be considered as strong even though they exhibited significant effects. On the contrary, the loss of IC at the mesial aspect could decrease 0.381 times when the opposing apparatuses are removable partial dentures compared to natural teeth or implants. Further, the loss of IC could decrease 0.460 times when the adjacent teeth are splinted compared to a nonsplinted condition. It is considered that the high occlusal forces exerted on the adjacent teeth may enhance mesial migration, which results in loss of IC.[9] Less force would be exerted by an opposing removable partial denture than natural teeth or implants. It is also evident that splinted teeth can be more resistant to force, which may induce migration more than in nonsplinted teeth. In this regard, these two factors would be noticeable in a clinical situation.

Overall, appropriate informed consent should be obtained before the commencement of treatment, and close attention should be paid at follow-up visits to IC areas at the mesial aspect after the delivery of an implant-supported prosthesis in the mandible. Moreover, additional care should be given to elderly patients and to patients in whom the opposing teeth are natural teeth or implants and the adjacent teeth are nonvital and nonsplinted. It is also recommended that definitive implant superstructures should be retrievable by clinicians, since the loss of IC is relatively frequent in clinical situations.

Conclusion

Within the limits of the present study, the following conclusions can be made:

- The loss of IC between implant prostheses and adjacent teeth was observed in 43% of the study sample.
- The rate of loss of IC at the mesial aspect was significantly higher than that at the distal aspect; the rate of loss of IC in the mandible was significantly higher than that in the maxilla.
- The rate of loss of IC increased over time, and half of the IC areas might be lost in 5.5 years.
- Age, the state of the opposing dentition, the vitality of the adjacent teeth, and splinting of the adjacent teeth significantly affect the loss of IC at the mesial aspect of implant prostheses.

The loss of IC between fixed implant prostheses and adjacent teeth was observed frequently at follow-up visits, especially at the mesial aspect of the prostheses. It is considered that this phenomenon may induce food impaction and cause an adverse effect on the peri-implant tissue. Hence, in a clinical situation, appropriate informed consent and careful maintenance of IC areas between implants and adjacent natural teeth are important at follow-up visits.

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Literature Abstract

Evaluation of accuracy of multiple dental implant impressions using various splinting materials

The present study compares the three-dimensional accuracy of casts using a nonsplinted impression technique with those made using the splinted technique with various splinting materials. A reference cast with four implant analogs (Nobel Replace Regular Platform) positioned in the mandibular symphiseal region was fabricated. Sixteen custom impression trays were made using light-cured acylic resin sheets and were left undisturbed for 24 hours prior to use. The trays were divided into four groups based on the impression technique used. In all four groups, impression copings were coated with polyether adhesive, allowed to dry for 15 minutes, and the impression was made using a polyether. In group A, impression copings were not splinted. Group B impression copings were splinted with acrylic resin (GC Pattern Resin), group C impressions copings were splinted with bite registration addition silicone (Imprint Bite), and group D impression copings were splinted with bite registration polyether (Ramitec). Implant replicas were attached to the impression copings and all impressions were poured with type IV dental stone. The three-dimensional accuracy of the poured casts was evaluated using a coordinate measuring machine. In the results for x-axis analysis, the nonsplinted and pattern resin-splinted groups displayed reduced interimplant distances, while the silicone-splinted and polyether-splinted groups displayed increased distances. In the y-axis analysis, the silicone-splinted group showed the greatest increase while the polyether-splinted group displayed the smallest increase in interimplant distances. In the z-axis analysis the acrylic resin–splinted group showed the smallest error while the nonsplinted and silicone-splinted groups displayed greater deviations. The differences between the test groups were statistically similar and within the range observed in other studies. The study concluded that casts obtained from copings splinted with polyether bite registration material were the closest to the reference cast, followed by the acrylic resin, nonsplinted, and addition silicone–splinted groups. Choice of impression technique can be based on the clinical situation and clinician's preference. Further research with a larger sample size and different implants positions with a greater anteroposterior spread should also be investigated.

Hariharan R, Shankar C, Rajan M, Baig MR, Azhagarasan NS. *Int J Oral Maxillofac Implants* 2010;25:38–44. **References:** 33. **Reprints:**

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