Changes in proximal contact tightness between fixed implant prostheses and adjacent teeth: A 1-year prospective study

Shuxin Ren, DDS,[a] Ye Lin, DDS,[b] Xiulian Hu, DDS,[c] and Ying Wang, DDS[d]

Creating tight proximal contact is the goal of both natural tooth-supported and implant-supported restorations. Proximal contact tightness (PCT) plays an important role in protecting the periodontal structures against damage due to food impaction.[1] However, as more and more partially edentulous patients choose osseointegrated dental implants to replace missing teeth, tight proximal contact in the long term may not be as easy to obtain in implant-supported prostheses as that in natural tooth-supported prostheses.[2] In clinical practice, food impaction, although not considered a complication of implant-supported restoration, is a common complaint after delivery of such restorations.[3] Recently, studies[2,4] have reported frequent proximal contact loss between fixed implant prostheses and adjacent teeth (in as many as 43% of patients), which increased throughout the follow-up period. In addition, the rate of contact loss at the mesial aspect was significantly greater than that at the distal aspect. Because of the ankylotic nature of dental implants, contact loss is most likely caused by mesial migration of the anterior adjacent teeth.[5,6] Serial long-term aging studies[7-9] of the changes of dental arches in normal adults also support

ABSTRACT

Statement of problem. No study has evaluated consecutive changes in proximal contact tightness (PCT) between fixed implant prostheses and adjacent teeth after delivery.

Purpose. The purpose of this clinical study was to investigate consecutive biological changes in PCT between fixed implant prostheses and adjacent teeth after placement.

Material and methods. Eighteen participants who had been treated with a single first molar implant in the mandible were included. Mesial and distal PCT were measured using the custom-made contact pressure system at immediate crown delivery (T0), 3-month follow-up (T1), and 1-year follow-up (T2). The PCT of natural teeth in the mesial direction of the same quadrant was also measured at T2 as a control. Repeated-measures analysis of variance (ANOVA) and 1-way ANOVA were used for statistical analysis.

Results. At T0, the PCT between fixed implant prostheses and adjacent teeth was designed deliberately to be higher than the PCT between natural teeth. Using multivariate analyses, the PCT between fixed implant prostheses and adjacent teeth decreased between T0 and T1 (*P*<.001), while there was no significant difference between T1 and T2 (*P*=.506). At T2, the distal PCT was tighter than the mesial PCT (*P*<.001); however, no statistical difference was found in the PCT between the implant-supported restoration and the natural teeth.

Conclusions. PCT decreased significantly at both mesial and distal sites over time. The major changes occurred over the 3-month period after crown delivery. (J Prosthet Dent 2016;115:437-440)

this theory. A significant decrease in arch length was observed with increased age. However, because of to the lack of a proper measurement method, the migration pattern of adjacent teeth and consecutive changes in PCT after implant-supported restoration delivery are still unclear. A prospective study with an objective and quantifiable measurement of PCT is required to better understand the changes in PCT between an implant and adjacent teeth.

The purpose of this clinical study was to measure the PCT between fixed implant prostheses and adjacent teeth at delivery, 3-month follow-up, and 1-year follow-up

[a]Attending, Department of Implantology, Peking University School of Stomatology, Beijing, China.
[b]Professor, Department of Implantology, Peking University School of Stomatology, Beijing, China.
[c]Associate Professor, Department of Implantology, Peking University School of Stomatology, Beijing, China.
[d]Attending, Department of Implantology, Peking University School of Stomatology, Beijing, China.

Clinical Implications

Deliberately increased proximal contact tightness between fixed implant prostheses and adjacent teeth at delivery was unstable and diminished in less than 3 months. Contact loss between fixed implant prostheses and adjacent teeth may be more likely to occur at the mesial than at the distal-proximal contact sites in the long term.

and to investigate the change in PCT between implant prostheses and natural teeth.

MATERIAL AND METHODS

Twenty consecutive patients who had been treated with a single mandibular first molar implant between June 2012 and June 2013 at the Department of Implantology, Peking University of Stomatology Hospital, were included. Participants were evaluated and selected for the study based on the following inclusion criteria: good general health, natural adjacent teeth, and natural opposing teeth. Exclusion criteria included severe periodontal disease, diastemas between posterior teeth, adjacent teeth with a mobility score of greater than 1, adjacent teeth with apical pathology, and severe malocclusion. The study was performed with the approval of the Ethics Committee of Peking University of Stomatology Hospital. Written informed consent was obtained from each participant before the start of the treatment.

All surgical and restorative phases were performed by dentists in the Department of Implantology, Peking University of Stomatology Hospital. Ten men and 10 women with an average age of 40 ±11 years were recruited to the study. The implant systems used in the study were Replace (Nobel Biocare) and Ankylos (Dentsply Intl). All implants were placed in a healed site using a 1-stage or 2-stage protocol.[10] The definitive prostheses were delivered 4 to 5 months after implant placement. Prostheses were screw-retained or cement-retained, and included ceramic crowns, metal ceramic crowns, and cast metal crowns. PCT was measured at the mesial and distal-proximal contact of the implant-supported prosthesis. All measurements were performed by 1 investigator (S.R.). The participants were seated in a dental chair with a standardized seating position, which was reproduced for each participant by the unit's preset positioning system.

PCT was measured using the custom-made contact pressure system (Fig. 1) that was based on the tooth pressure meter, a device fabricated at the University of Technology, Delft, the Netherlands.[11] The system used a 0.05-mm-thick metal strip inserted interdentally from an occlusal direction (Fig. 2). The metal strip was connected to the digital force gauge (HF-50; ALIYIQI). The tightness of the proximal contact was quantified as the maximum frictional force when the strip was slowly removed in a buccal-lingual direction. The maximum force was recorded on the screen of the gauge for each measurement when the gauge was switched to peak-mode. Three measurements were made at each site with the target maximum range of 0.5 N. Measurement outcomes exceeding this range required repeating the measurement. The result of a single measuring site consisted of the mean value of these 3 outcomes.

Contact tightness was recorded at 3 time points: immediately after crown delivery (T0), at 3-month follow-up (T1), and at 1-year follow-up (T2). At T2, besides the mesial and distal contact measurements, the PCT between the natural teeth in the mesial direction of the same quadrant was also measured and used as a control to register changes in contact tightness.

Statistical analysis was performed with statistical software (SPSS v12; IBM Corp). After testing the data for normal distribution, mean values and standard deviations of the contact tightness at the 3 time points were calculated. The PCT between fixed implant prostheses and adjacent teeth was compared at T0, T1, and T2 using repeated measures analysis of variance (ANOVA). At T2, the mesial and distal PCT was compared with the control contact tightness using 1-way ANOVA (α=.05).

RESULTS

Twenty participants were included in the study. Two participants complained of food impaction in the mesial site of the implant at T1; subsequently, the implant-supported restorations were removed and adjusted in the dental laboratory. Data from the remaining 18 patients were recorded and analyzed.

The means and standard deviations of contact tightness at 3 different time points are presented in Table 1. Changes in the mesial and distal PCT between fixed implant prostheses and adjacent teeth at T0, T1, and T2 are shown in Figure 3.

To obtain a tight PCT and prevent food impaction in the long term, the initial PCT of the implant was designed to be higher than that between natural teeth. At the 3-month follow-up after restoration delivery, the PCT was significantly decreased at both the mesial and distal sites (P<.001). At the 1-year follow-up after restoration delivery, the mesial PCT was decreased compared with the mesial PCT at the 3-month follow-up. By contrast, the distal PCT of the implant at T2 was mildly increased compared with T1. However, no statistical difference was found in PCT between T1 and T2.

At the 1-year follow-up, the mesial and distal PCT was compared with the control PCT of natural teeth. At

Figure 1. Custom-made contact pressure system with digital force gauge and metal strip.

Table 1. Means and standard deviations of contact tightness

Contact Site	T0 (mm)	T1 (mm)	T2 (mm)
Mesial contact of implant	6.70 ±3.21	1.79 ±1.26	1.14 ±1.24
Distal contact of implant	6.27 ±2.85	2.21 ±1.39	3.23 ±2.18
Contact of natural tooth			2.00 ±1.74

T0, immediately after crown delivery; T1, 3-month follow-up; T2, 1-year follow-up.

T2, the distal PCT was tighter than the mesial PCT ($P<.001$); however, no statistical difference was found between the PCT of implant-supported restorations and the PCT of natural teeth.

DISCUSSION

At the 3-month follow-up, the PCT between fixed implant prostheses and adjacent teeth was significantly decreased and generally reached the level of PCT between natural teeth. This result indicated that the deliberate increase in the PCT was not stable and would be diminished in less than 3 months. In classical orthodontic theory, when the orthodontic force is greater than 1 N, the average rate of tooth movement is approximately 1.0 to 1.5 mm per month. When the PCT between fixed implant prostheses and adjacent teeth is too tight, the biological process is similar to the situation in which an orthodontic force is applied to the adjacent teeth with implant anchorage. In this situation, the PCT would quickly decrease because the periodontal tissue around the teeth typically responds to the orthodontic force within 2 weeks. Animal and human experiments have also shown that the magnitude of force has little effect on the rate of tooth movement.[12,13] In all, the deliberate increase in PCT had no positive effect on preserving the PCT between the fixed implant prostheses and adjacent teeth in the long term.

A gradual loss of mesial PCT between fixed implant prostheses and adjacent teeth was observed, although the tendency was not very remarkable because of the short follow-up duration, which was in agreement with

Figure 2. Clinical image of proximal contact tightness measurement.
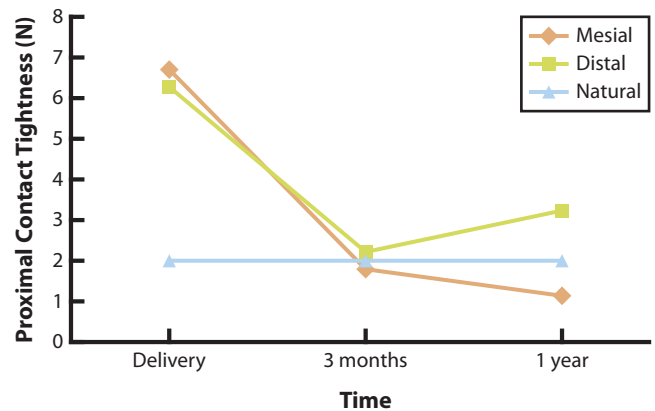
Figure 3. Changes of proximal contact tightness.

previous studies.[2,4] Obvious open contact anterior to the implant restoration on long term follow-up also was observed in clinical reports.[6] Correspondingly, the distal PCT between fixed implant prostheses and adjacent teeth was stronger than the mesial PCT. This discovery, in accordance with the loss of mesial PCT, supported the theory of mesial migration of the teeth. Serial long-term aging studies[7-9] also showed that a significant decrease in arch length was observed with increased age. Bishara et al[7] reported the decrease in total arch length over 20 years as 1.0 mm in the maxilla and 0.8 mm in the mandible, which corresponded to an annual mesial migration of teeth of 0.005 mm in the maxilla and 0.004 mm in the mandible. Tibana et al[9] reported similar results, where the arch perimeter decreased 0.67 mm in the upper arch and 0.71 mm in the lower arch over a 28-year observation period.

Proper, even, tight PCT in the resting state may not completely prevent food impaction.[14] During jaw functioning, teeth are displaced; however, the implant-supported prosthesis is ankylosed. In natural tooth dentition, occlusal contact was shown to have a great impact on PCT.[11] PCT increased with clenching

strength in both the maxilla and the mandible, and occlusal tooth contact patterns influenced PCT during clenching.[15,16] In implant-tooth mixed dentition, a limited study showed that high occlusal force on the adjacent tooth might enhance the mesial migration, resulting in a higher rate of mesial IC loss.[5] Further studies are needed to determine the dynamic changes in PCT between fixed implant prostheses and adjacent teeth during clenching.

CONCLUSIONS

The gradual loss of mesial IC between fixed implant prostheses and adjacent teeth is irreversible. This biological phenomenon begins at the delivery of prostheses and continues with age. At the treatment planning stage, adequate communication on this issue between dentists and patients is necessary. Retrievable implant-supported restorations, such as screw-retained restorations are recommended. Oral health instructions after delivery should emphasize the use of dental floss especially at the mesial proximal contact. In addition, regular long-term follow-up is crucial because subtle adult craniofacial growth may occur.

REFERENCES

1. Jernberg GR, Bakdash MB, Keenan KM. Relationship between proximal tooth open contacts and periodontal disease. J Periodontol 1983;54: 529-33.
2. Koori H, Morimoto K, Tsukiyama Y, Koyano K. Statistical analysis of the diachronic loss of interproximal contact between fixed implant prostheses and adjacent teeth. Int J Prosthodont 2010;23:535-40.
3. Yi SW, Carlsson GE, Ericsson I, Kim CK. Patient evaluation of treatment with fixed implant-supported partial dentures. J Oral Rehabil 2001;28: 998-1002.
4. Byun SJ, Heo SM, Ahn SG, Chang M. Analysis of proximal contact loss between implant-supported fixed dental prostheses and adjacent teeth in relation to influential factors and effects. A cross-sectional study. Clin Oral Implants Res 2015;26:709-14.
5. Wei H, Tomotake Y, Nagao K, Ichikawa T. Implant prostheses and adjacent tooth migration: preliminary retrospective survey using 3-dimensional occlusal analysis. Int J Prosthodont 2008;21:302-4.
6. Daftary F, Mahallati R, Bahat O, Sullivan RM. Lifelong craniofacial growth and the implications for osseointegrated implants. Int J Oral Maxillofac Implants 2013;28:163-9.
7. Bishara SE, Treder JE, Damon P, Olsen M. Changes in the dental arches and dentition between 25 and 45 years of age. Angle Orthod 1996;66:417-22.
8. Carter GA, McNamara JA Jr. Longitudinal dental arch changes in adults. Am J Orthod Dentofacial Orthop 1998;114:88-99.
9. Tibana RH, Palagi LM, Miguel JA. Changes in dental arch measurements of young adults with normal occlusion—a longitudinal study. Angle Orthod 2004;74:618-23.
10. Tallarico M, Vaccarella A, Marzi GC. Clinical and radiological outcomes of 1-versus 2-stage implant placement: 1-year results of a randomised clinical trial. Eur J Oral Implantol 2011;4:13-20.
11. Loomans BA, Opdam NJ, Roeters JF, Bronkhorst EM, Plasschaert AJ. Influence of composite resin consistency and placement technique on proximal contact tightness of Class II restorations. J Adhes Dent 2006;8:305-10.
12. Dudic A, Giannopoulou C, Kiliaridisc S. Factors related to the rate of orthodontically induced tooth movement. Am J Orthod Dentofacial Orthop 2013;143:616-21.
13. Pilon JJGM, KuijpersJagtman AM, Maltha JC. Magnitude of orthodontic forces and rate of bodily tooth movement. An experimental study. Am J Orthod Dentofacial Orthop 1996;110:16-23.
14. Newell DH, John V, Kim SJ. A technique of occlusal adjustment for food impaction in the presence of tight proximal contacts. Oper Dent 2002;27:95-100.
15. Oh SH, Nakano M, Bando E, Shigemoto S, Kori M. Evaluation of proximal tooth contact tightness at rest and during clenching. J Oral Rehabil 2004;31: 538-45.
16. Oh SH, Nakano M, Bando E, Keisuke N, Shigemoto S, Jeong JH, et al. Relationship between occlusal tooth contact patterns and tightness of proximal tooth contact. J Oral Rehabil 2006;33:749-53.

Corresponding author:
Dr Ye Lin
Department of Implantology
Peking University School of Stomatology
No. 22 Zhongguancun South Street
Haidian District, Beijing
PR CHINA
Email: yorcklin@263.net