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Clinical assessment of food impaction after implant restoration: a retrospective analysis

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Abstract

In the current study the incidence of food impaction between implant-supported fixed dental prostheses and adjacent teeth was determined and the factors that influence food impaction were identified. Seven hundred seventy-nine implant prosthetic crowns and 879 adjacent sites from a pool of 489 patients were retrospectively studied. Food impaction existed in 16.6% of patients with implant restorations at the follow-up evaluations. Food impaction occurred more frequently on the mesial aspect of the implant prosthesis and the molar area. Among the factors that affected food impaction, proximal contact loss was shown to be the major cause (78.6%), while the incidence of food impaction on the mesial and distal aspects was 58.0% and 20.6%, respectively. Based on single-factor analysis of variance, gender, implant location, mesial and distal aspects of the prosthesis, and lost time before implant restoration were the factors that influenced proximal contact loss in patients ($P < 0.05$). In conclusion, proximal contact loss was shown to be highly associated with food impaction. Thus, gender, the molar area, the mesial aspect of the prosthesis, and the lost time before implant restoration should be fully considered. Guidance on the proper use and maintenance of prostheses is essential to achieve an optimal outcome.

Keywords: food impaction; implant restoration; implantology; maintenance of the prostheses; proximal contact loss.

Practical Application: Improving the oral environmental and protect dental implants.

1 Introduction

In recent years, dental implant technology with high chewing efficiency and good appearance are important outcomes when restoring missing teeth and fixed dentures and is widely used in the clinic (Bazrafshan & Darby, 2014; Pieralli et al., 2017; Simion et al., 2018). Although the success rate for dental implants in patients has been reported to be excellent (Mello et al., 2017), a number of complications are associated with implant therapy. Specifically, food impaction after prosthetic treatment is a common and irritating problem for patients as well as clinicians (Chopra et al., 2019). Food impaction is a complication with a high prevalence in the population that is frequently observed between implant prostheses and adjacent teeth after long-term follow-up visits, especially in the posterior area (Shin et al., 2014).

Food impaction most often occurs with food debris or particulate fibers during chewing and macerating ingested food. These food dregs and fibers are pushed into the clearances between implant prostheses and adjacent teeth or the buccal and lingual zones of implanted prostheses by occlusal forces, exposure of the gingival embrasure, or owing to gingival shrinkage. Studies have recently shown that many factors, such as altered morphology of the implant prosthesis, loss of proximal contact, and abnormal occlusal load, can increase the risk of food impaction (Elias et al., 2015; Greenstein et al., 2016; Craddock et al., 2007); however, the critical factors have not been fully addressed.

This clinical study was conducted to determine the incidence of food impaction between implant prostheses and adjacent teeth in patients with dental implants and identify the main factors associated with food impaction using a comprehensive statistical analysis of the clinical data. The results would potentially help clinicians to provide guidelines for appropriate prevention of food impaction.

2 Material and methods

2.1 Selection of study samples

This study was approved by the Research Ethics Committee of our university. Patients who underwent implant fixed restoration and follow-up evaluations for 3-36 months from January 2015 to December 2018 at the Oral Hospital of our university were recruited for this study. Informed consent was obtained from all patients. Three dental implant systems with diameters of 3.6-5 mm, lengths of 7-13 mm, and a repair procedure for a single or consecutive crown were purchased from ITI (Straumann AG, Waldenburg, Switzerland), Bego (Bremen, Germany), and Dentium Co. (Seoul, Korea).

Patient samples were selected based on the following inclusion criteria: 1. Implant procedure and prostheses had already been performed. 2. Implant prostheses were only supported by implants. 3. Implant status was regularly reviewed by clinicians and patients were in good compliance. 4. Good proximal contact and healthy adjacent teeth were confirmed after the implant procedure. The exclusion criteria were as follows: 1. evidence of severe periodontal disease; 2. edentulous jaw with implant-

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supported denture repair; 3. union crown restoration between the implant and natural teeth; and 4. poor proximal contact. By following these selection criteria, 779 implant prosthetic crowns from a pool of 489 recruited patients, including 261 males and 228 females with an average age of 44 years (range, 18-73 years), were involved in this study.

2.2 Implant prostheses

The implant prostheses were inserted following the standard protocol by prosthodontic specialists at the Hospital of Stomatology (China Medical University). The edge, occlusal contact, and proximal contact of the prosthesis were adjusted to obtain an optimal prosthesis implant. Upon insertion of the prosthesis, the proximal contacts between the prosthesis and adjacent natural teeth were evaluated using dental floss with a thickness of 50 μm (Essential Floss; Oral B^{TM}, city, state, USA) until the clinical requirements were satisfied. The prosthesis displayed good proximal contact when the dental floss could pass through the contact with high resistance, but without breaking.

After the implant prosthesis, porcelain powder was applied by the technicians to form good proximal contact. All materials were used according to the manufacturer's instructions. When the patients had severe pain from the implanted area or the dental floss could not pass through the contact or was broken due to excessive resistance, the adjustment on the proximal surface was performed to decrease the resistance and damage. If necessary, additional occlusal adjustments were made with special instruments. The status of resin bonding (3M Unitek, city, state, USA) in the implanted prosthesis was rechecked following the bonding procedure.

2.3 Follow-up

Recall appointments were scheduled after 3, 6, and 12 months of the dental implant. Each recall visit was required for follow-up evaluations and included occlusion assessments and periodontal implant mucosa conditions. X-ray examinations were also performed at each visit (Figure 1).

Implants were examined for stability and discomfort on function (Figure 2). If the prostheses were uncomfortable to patients after insertion, a follow-up analysis with an interval of 6 months after the final visit was conducted. The degree of proximal contact tightness was evaluated using dental floss. At all recall visits, the patients were asked whether they had experienced any food impaction in the proximal embrasure between the teeth.

2.4 Statistical analysis

Multiple factors were recorded and detailed from the pool of 489 patients, including gender, age, the location of the implanted prosthesis, splinting of the implants, time elapsed before implant restoration, food impaction, the number of days after receiving the prosthesis, the region of prosthesis insertion, proximal contact loss, the region of proximal contact loss, periodontal tissue conditions, the condition of the adjacent teeth, the state of the opposing teeth, and evidence of severe tooth wear. The adjacent site of the prosthesis was used as an observer unit, and analysis of the incidence and main factors associated with food impaction was performed. Furthermore, the factors that may affect proximal contact loss were examined by single-factor analysis of variance (ANOVA). The data were statistically analyzed using SPSS statistical analysis software (version 13.0), and a P value < 0.05 was considered to represent a significant difference.

3 Results and discussion

A total of 779 implanted teeth and 879 adjacent sites from 489 patients were analyzed. The average age of patients was 44.1 years. Of the patients, 16.6% (81 of 489) experienced food impaction, a mean of 8.2 months after implant when food impaction occurred. As shown in Table 1, food impaction

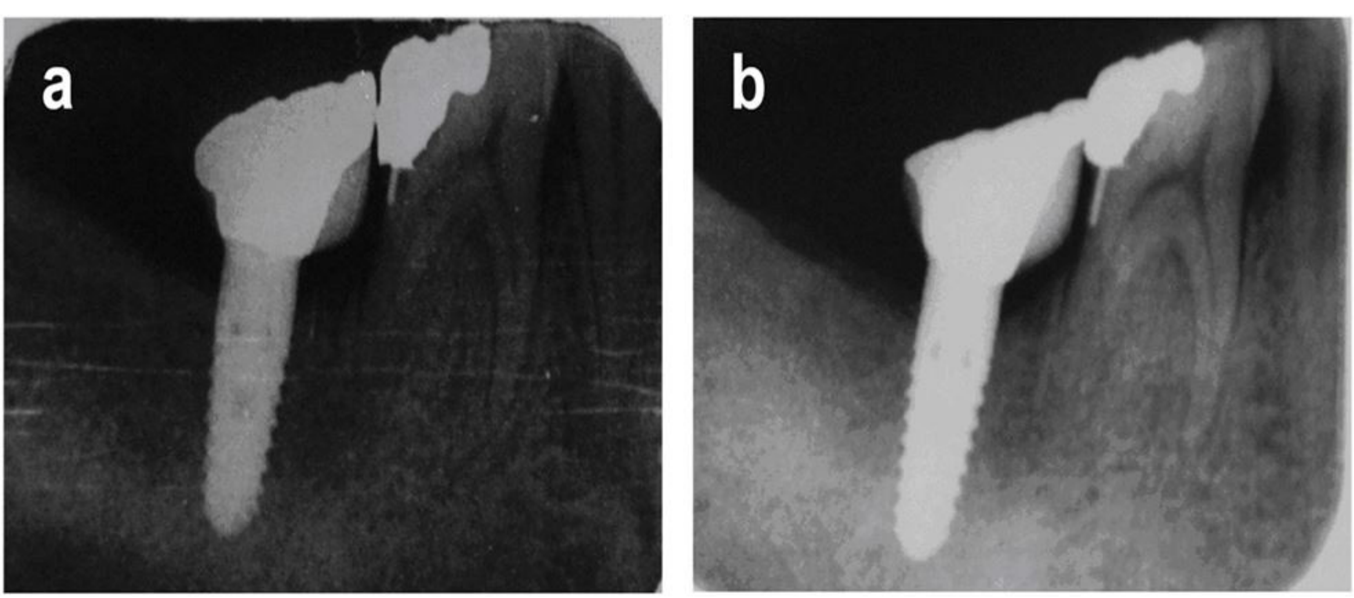

Figure 1. Representative radiograph of a dental implant at different visits. A patient with a dental implant (a) and 8 months later (b).

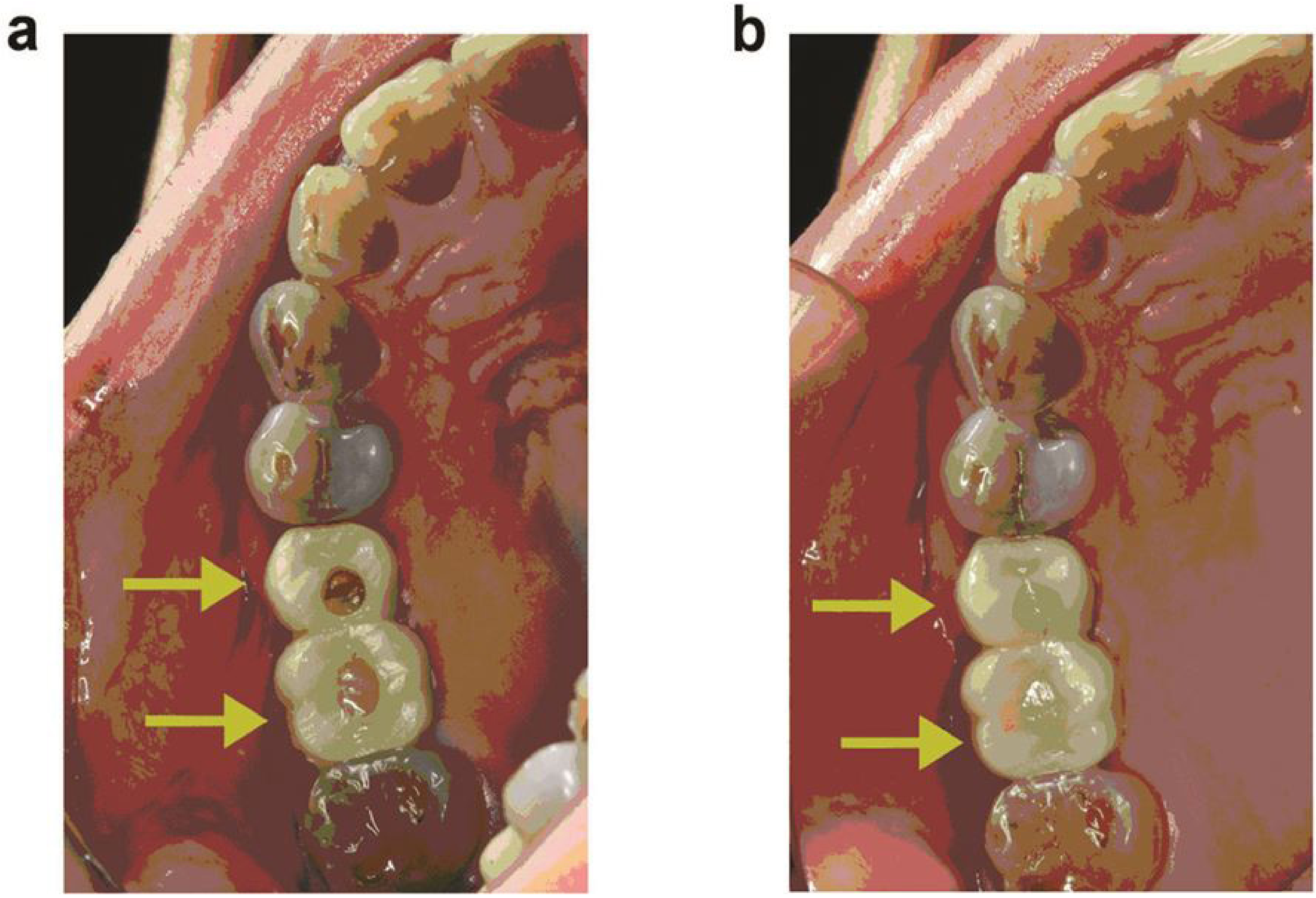

Figure 2. Representative white light images of dental implants on a follow-up visit. A patient with a dental implant (a) and with mesial porcilian (b).

mainly occurred at the mesial and distal sites of the prosthesis, with an occurrence rate of 15.9% (89 of 561) and 11.6% (37 of 318), respectively. The mandibular incidence was 15.4% (70 of 456), which was slightly higher than the maxillary (13.2% [56 of 423]). The incidence of food plugs in the molar area was 15.4% (92 of 597), which was higher than the non-molar area (12.1% [34 of 282]; Table 1).

Because of the high occurrence of food impaction among patients with prostheses, we next focused on the major factors that influence food impaction. Based on follow-up examination results, proximal contact loss between implanted prostheses and adjacent teeth was essential for food impaction. Among such patients, dental floss easily passed through the contact without resistance. The incidence of proximal contact loss at the mesial and distal sites of prostheses was 78.6% (99 of 126); the mesial sites accounted for 58.0% and the distal sites accounted for 29.6% (Table 2). Poor shape, including poor protrusion of the proximal surface, poor embrasures, loss of the exhaust groove, and proximal contact caries represented the second key factor for food impaction occurring at the mesial sites of prostheses (4.8%). For distal prostheses, adjacent tooth loosening and an excessive incline were the second key factor for food impaction (5.6%). The other factors for food impaction among the patients with mesial and distal prostheses are summarized in Table 2.

Table 1. Description of patient information and food impaction.

	Food impaction	Total	Rate (%)
No. of patients	81	489	16.6
No. of implants	98	779	12.6
No. of proximal embrasures	126	879	14.3
Mesial	89	561	15.9
Distal	37	318	11.6
Maxillary	56	423	13.2
Mandibular	70	456	15.4
Non-molar	34	282	12.1
Molar	92	597	15.4

Among the patients with proximal contact loss in mesial and distal prostheses, the crucial factors were assessed by single-factor ANOVA. As shown in Table 3, proximal contact loss was significantly correlated with gender, implant position (insertion in molar or non-molar teeth), proximal contact position (mesial or distal implant), and time elapsed before implant restoration ($P < 0.05$). Women were more likely to have adjoining loss than men (14.4% vs. 9.4%). Seventy-three of 511 mesial sites had contact loss, which was far greater than the distal sites (26 of 368). In addition, implant restoration performed before < 1 year had elapsed was more likely to lead to contact loss than if > 1 year had elapsed (14.3% vs. 8.7%); however, age, jaw position (mandible

Table 2. Reasons for food impaction.

	Mesial	Distal	Total
Proximal contact loss	73 (58.0%)	26 (20.6%)	99 (78.6%)
Poor shape (Poor protrusion of proximal surface, poor embrasures, loss of exhaust groove)	6 (4.8%)	1 (0.8%)	7 (5.6%)
Inconsistent height of marginal ridge	3 (2.4%)	1 (0.8%)	4 (3.2%)
Porcelain cracking	1 (0.8%)	0 (0%)	1 (0.8%)
Proximal decay or poor restoration	4 (3.2%)	2 (1.6%)	6 (4.8%)
Filling type cusp	2 (1.6%)	0 (0%)	2 (1.6%)
Adjacent tooth mobility or excessive incline	0 (0%)	7 (5.6%)	7 (5.6%)
Total	89	37	126

Table 3. Single-factor ANOVA of contact loss.

		Contact	Contact loss
Proximal contact position	Mesial (n = 511)	438	73
	Distal (n = 368)	342	26
Jaw position	Maxilla (n = 423)	379	44
	Mandible (n = 456)	401	55
Gender	Male (n = 552)	500	52
	Female (n = 327)	281	47
Implant position	non-molar (n = 282)	259	23
	molar (n = 597)	521	76
Age	Age≥50 (n = 596)	528	68
	Age<50 (n = 283)	252	31
Splinting of implants	Single crown (n = 494)	443	51
	Splinted crown (n = 385)	337	48
State of opposing dentition	Natural teeth (n = 627)	555	72
	Fixed prosthesis (n = 252)	225	27
Abrasion of on the jaws	Serious abrasion (n = 83)	70	13
	Not serious abrasion (n = 796)	710	86
Loss time before implant restoration	More than 1 year (n = 481)	439	42
	Less than 1 year (n = 398)	341	57

n: number.

or maxilla), splinted or non-splinted implants, status of opposing dentition (natural condition of the jaw teeth or fixed prosthesis), as well as the abrasion condition of the jaw teeth (severe or not severe), had no observable correlation with the generation of contact loss ($P > 0.05$; Table 3).

The body of evidence has demonstrated that dental implants are an important approach among many disciplines to achieve oral rehabilitation, while concerns about the biological and mechanical complications of implants persist (Mello et al., 2017; Pjetursson et al., 2015; Sailer et al., 2018]. Indeed, food impaction has become one of the most common complications that occurs in patients with dental implants at the 1-year follow-up evaluation and beyond (Wat et al., 2011).

In this study we showed that the incidence of food impaction in patients with prostheses was 16.6%, while Koori et al. (Koori et al., 2010) reported an incidence of 43% and Bryn (Byun et al., 2015) reported an incidence of 20%. The reason that the incidence determined in current study was lower than other studies was likely due to the shorter duration of observation because it has been demonstrated that the incidence of food impaction increases over the follow-up time (Koori et al., 2010; Wei et al., 2008). In addition, this study showed that food impaction mainly occurred in the mesial and distal sites of implant restorations and the incidence of food impaction at the mesial prostheses was higher than distal prostheses. Food impaction was particularly common at rear teeth sites. Moreover, the molar teeth area had a higher incidence of food impaction than non-molar teeth areas, while the mandibular area had slightly higher rates than the maxillary areas. These results were consistent with the study reported by Bryn et al. (Byun et al., 2015).

There are some factors that are associated with food impaction, such as proximal contact loss, poor shape of the restoration, inconsistent height of the marginal ridge, porcelain cracking, proximal decay or poor restoration, adjacent tooth mobility, filling type cusp, and excessive incline. The most important factors are poor proximal contact and diastema between implant-supported fixed dental prostheses and adjacent teeth. Additionally, the proximal contact loss rate increases over the follow-up period, especially at the mesial sites (Koori et al., 2010; Wei et al., 2008). It should be noted that a good proximal contact includes correct position of the proximal contact, completed morphology of the marginal ridge and developmental groove, and presence of right diastema between dental areas. Generally, the diastema between the proximal contacts of restoration should be within 100 μm, while food impaction most often occurs when the diastema is between 100 and 300 μm. The appropriate proximal contact is defined as successfully passing dental floss through the interproximal contacts with heavy resistance without breaking (Browet & Gerdolle, 2017). In this study we used a waxed 50-μm dental floss to assess the degree of proximal contact, and controlled the diastema of restoration within 100 μm. The physiologic mesial migration of the teeth and occlusal changes after repair were shown to be other reasons for proximal contact loss in partial dental zones. Therefore, mesial drifting of the teeth adjacent to the osseo-integrated implant area is an important reason for proximal contact loss at the mesial aspect (Pang et al., 2017; Heij et al., 2006).

It has been reported that the difference in physiologic behavior between natural teeth and dental implants in the jaw is mainly due to absent attachment of periodontal ligaments in dental implants (Atsuta et al., 2016). The average movement of natural teeth during mastication is 28 and 56-75 μm in the vertical and horizontal directions, respectively (Wat et al., 2011). Dental implants, however, are only allotted 5 μm for vertical and 17-66 μm for horizontal movement (Graves et al., 2016). Therefore, the movement of natural teeth is more flexible than implant movement in the horizontal direction, and the proximal contact loss and diastema more likely involve the mesial aspect of implant restoration. Dörfer et al. (2000) reported that natural teeth move and the proximal contact strength between teeth is regarded as a physiologic entity of multifactorial origin because proximal contact is significantly influenced by location, tooth type, chewing, and time of day variation; however, implants are relatively stable (Saito et al., 2020; Hamed et al., 2019). Therefore, the mesial movement differences between implants and natural teeth are related to proximal contact loss of implant restoration at the mesial site (Wei et al. 2008).

Except for proximal contact loss, the position of implants, marginal ridge of restoration, filling cusp of opposite teeth, good condition of periodontal tissues, and fullness of gingival papilla are all associated with food impaction (Chopra et al., 2019; Nagarsekar et al., 2016). It should be noted that periodontitis is one of the most important factors for food impaction (Bidra, 2014); however, periodontitis must be under strict control before dental implant insertion, thus few patients will experience food impaction from severe periodontitis. In this study correct position was ensured to form the adjacent points during crown-making. Adjacent gaps would be recovered within 100 μm when dental floss encounters some resistance passing through adjacent points during a clinical examination. The marginal ridge contour of the crown chosen here was consistent and had a good appearance and food draining.

There are several methods to avoid further food impaction in patients with prostheses. One of the most commonly used methods is to adjust the pestle type of jaw cusps or ridges of opposing dentition. While expanding the outreach gap and building a discharge channel from the occlusal surface to the outward gap are other useful approaches to prevent food impaction (Khairnar, 2013). Food impaction and diastema can be caused by mesial movement of the mesial teeth and distal movement of the distal teeth under the influence of the bite force. The mesial inclined plane of distal teeth is suggested for adjustments in the diastema, and thus facilitates mesial movement with the intent of decreasing diastema and improving food impaction under the influence of the bite force (Mah et al., 2015).

In this study the related risk factors for proximal contact loss were also analyzed. Specifically, proximal contact loss was significantly associated with gender, implant (molar or non-molar teeth), proximal contact (mesial and the distal implant), and loss time before implant restoration. Female patients, molar teeth, the mesial aspect, and time elapsed < 1 year before implant restoration were more important factors to lead to proximal contact loss. While other factors, such as age, jaw position (mandible or maxilla position), splinted or non-splinted implants, status of opposing dentition (natural jaw teeth or fixed repair), and the abrasion condition of the jaw teeth (severe or not severe), had no correction with the loss of adjacent points.

Generally, bone density in women is lower than men, thus tooth movement is more frequently observed in women. For this reason, it can be considered that gender difference with respect to proximal contact loss is mainly associated with the difference in bone density between females and males. Because different proximal contact forces will be gained at different implant insertion locations, implant location is correlated with proximal contact loss. In this study we observed that the proximal contact strength was significantly lower in the maxilla when compared with the mandible under the effect of bite force. Similarly, the strength of proximal contact was lower in anterior than th posterior teeth ($p < 0.05$). Dörfer et al. (2000) reported that the minimum proximal contact strength was located between the canine and the first premolar teeth, and the maximum proximal contact strength was located between the second premolar and the first molar teeth. In addition, mesial movement of the teeth can induce proximal contact loss because of the difference in proximal contact strength between the anterior and posterior teeth (Heij et al., 2006). Thus, the incidence of proximal contact loss in the molar area was higher than the non-molar area. The bite force in patients with severe abrasion is usually greater in patients with normal occlusion, thus it is easier to produce teeth movement and proximal contact loss under the effects of excessive bite force.

4 Conclusion

In summary, because food impaction and proximal contact loss are frequently observed at follow-up visits following implant restoration, guidance on the proper use and maintenance of prostheses should be provided. When creating new implant crowns, these indications should be fully considered to extend the life cycle of prostheses.

Within the limitations of this study, we concluded that proximal contact loss is a major cause of food impaction in patients with dental implants. Proximal contact loss is more likely in female patients at the molar area and mesial aspect, and associated with time elapsed < 1 year prior to implant restoration.

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