

Changes in the oral environment after placement of removable dentures in low caries risk patients

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We did a follow-up investigation that examined changes over time in the oral environment of low caries risk patients after initial placement of removable prostheses. Denture and Dentate groups of aged subjects were followed up over time to track changes in their oral environment. Seven oral environment factors were selected that strongly correlate with caries risk, including unstimulated and stimulated salivary flow rate, unstimulated and stimulated salivary buffering capacity, and oral bacteria (mutans streptococci, lactobacilli and *Candida*). Wilcoxon's signed rank test revealed that there were significant changes, and that the number of lactobacilli increased one year after placement of the dentures in the Denture group. No changes were noted in any of the factors in the Dentate group. We concluded that placement of removable dentures changed low caries risk to high for the number of lactobacilli. Future investigations should be done on preventive measures against the caries-inducing effect of denture placement. (*J Osaka Dent Univ* 2014 ; 48 : 87–92)

Key words : Saliva ; Dental caries activity tests ; Oral environment

INTRODUCTION

Japan has a high distribution of aged citizens. Dental treatment significantly contributes to a high QOL in the elderly. Many people lose teeth because of caries and/or periodontal diseases. It is important to find the causes for this and to take preventive measures. In particular, systemic diseases in the elderly tend to worsen the oral environment,¹ leading to an increased risk of caries. The caries activity test is useful in understanding the oral environment. A simple chairside test can measure the patient's unstimulated and stimulated salivary flow rate, unstimulated and stimulated salivary buffering capacity, and salivary microbial counts, including mutans streptococci, lactobacilli and *Candida*. Information on these oral environment factors can aid in preventing caries based on individual risk, and extending the life of dental restorations.

In Japan, missing teeth are usually replaced by fixed or removable prostheses. Using the saliva test, Närhi reported that salivary microbial counts were greater in elderly with dentures than in those with

natural dentition.² Our cross-sectional study, which used the same saliva test, reported that there were large differences in the number of cariogenic bacteria in the oral environment of elderly with fixed prostheses compared with those who had removable prostheses.³ Although these studies suggested that removable dentures may influence salivary microbial counts, it is still unknown whether they contribute to an increase in the counts. We did a follow-up study that examined the oral environment over time of low caries risk patients after initial placement of removable prostheses.

MATERIALS AND METHODS

Subjects and oral environment factors

The Denture group was 7 patients after initial placement of removable prostheses with a mean age of 69 ± 12 years, a mean number of remaining teeth of 20 ± 2.5, and a mean number of missing teeth of 8.3 ± 2.6. The Dentate group was 6 patients who had received crown and/or bridge treatment who had a mean age of 61 ± 3 years, a mean number of remain-

ing teeth of 24 ± 1.0 . All subjects had low caries risk based on a preliminary laboratory saliva test.

Oral environment examinations were performed 1.5 months (baseline) and 1 year (follow-up) after their prostheses were placed. The two groups of elderly subjects were followed up over time to compare their oral environment at baseline and at follow-up. The laboratory saliva test (Dentocult[®], Orion Diagnostica Oy, Espoo, Finland), which is a caries activity test, was used to evaluate the oral environment.⁴⁻⁶ We selected 7 oral environment factors that have a strong correlation with caries risk. They include unstimulated and stimulated salivary flow rate, unstimulated and stimulated salivary buffering capacity, and oral bacteria (mutans streptococci (SM), lactobacilli (LB) and *Candida* (CA)).

The study protocol was screened and approved for its ethical acceptability by the Committee on Experimental Research on Humans of Osaka Dental University (No. 040940). This study was performed at Osaka Dental University Hospital (Japan).

Saliva collection

The subject's saliva was collected between 9 : 30 and 11 : 30 in the morning, at least 1 hour after breakfast. Unstimulated saliva was sampled with the head in a forward inclined position for 10 min in a graduated tube to obtain an estimated flow rate (mL/min). Unstimulated saliva buffer capacity was determined using a laboratory saliva test (Dentobuff[®] strip, Orion Diagnostica Oy). The subjects were divided into three classes based on unstimulated saliva flow, and four

classes based on buffer capacity. The stimulated salivary flow rate was determined using saliva expectorated after chewing a 1 g paraffin pellet for 5 minutes. The buffering capacity of stimulated saliva was evaluated using Dentobuff[®] strips. The amount of bacteria for SM, LB and CA in the saliva was measured using Dentocult[®]. After incubation, the results were compared with a model chart contained in the kits to determine counts for SM, LB and CA. The results for unstimulated and stimulated salivary flow rate, as well as unstimulated and stimulated salivary buffering capacity, were divided into 3 and 4 classes, respectively, and the results for SM, LB and CA was divided into 3, 4 and 4 classes, respectively (Table 1). A higher class indicated increased caries risk.

A risk class of 0 or 1 for the stimulated salivary flow rate, the unstimulated salivary buffering capacity, the stimulated salivary buffering capacity, and SM were considered low risk. A risk class of 0 for the unstimulated salivary flow rate and LB were also considered low risk. A risk class of 3 was considered high risk for the unstimulated and stimulated salivary flow rate, for the unstimulated and stimulated salivary buffering capacity, for SM and for CA. Risk classes 2 and 3 for LB were categorized as high risk.

Statistical analysis

Each result of the seven factors was compared between the Dentate and Denture groups during the period from baseline to the follow-up. The results were analyzed by the Wilcoxon's signed rank test, with the significance level defined as 0.05.

Table 1 Classification of oral environment factors

Oral environment factors	Risk (class)			
	0	1	2	3
Unstimulated salivary flow rate (mL/min)	>0.3	0.1~0.3	≤0.1	—
Unstimulated salivary buffering capacity (pH)	≥6.0	4.5~6.0	4.0~4.5	<4.0
Stimulated salivary flow rate (mL/min)	≥1.1	0.9~1.1	0.5~0.9	<0.5
Stimulated salivary buffering capacity (pH)	≥6.0	4.5~5.5	4.0~4.5	<4.0
Mutans streptococci (CFU/mL)	<1 × 10 ⁵		1 × 10 ⁵ ~1 × 10 ⁶	>1 × 10 ⁶
Lactobacilli (CFU/mL)	≤1 × 10 ³	1 × 10 ⁴	1 × 10 ⁵	≥1 × 10 ⁶
<i>Candida</i> (CFU/mL)	≤1 × 10 ³	1 × 10 ⁴	1 × 10 ⁵	≥1 × 10 ⁶

Risk class : 0→4 (low→high), CFU : Colony forming units.

RESULTS

Figure 1 shows changes over time for the unstimulated salivary flow rate and buffering capacity after completion of the prosthetic treatment. There were no significant differences for the unstimulated salivary flow rate and the unstimulated salivary buffering capacity. The unstimulated salivary flow rate decreased in only one patient for each group. However, low caries risk was maintained in both groups for unstimulated salivary flow rate. All subjects showed low risk except for one patient for the unstimulated salivary buffering capacity test.

Figure 2 shows changes over time for stimulated salivary flow rate and buffering capacity after completion of the prosthetic treatment. The risk factor of stimulated salivary flow rate was unchanged in 6 of the 7 patients in the Denture group. However, the amount of saliva decreased in one patient. There were no significant differences. Although two subjects in the Dentate group showed an increase in the amount of saliva at the one year follow-up, no change in risk was noted in the other 4 subjects. With regard to the buffering capacity of stimulated saliva, no risk changes were noted in 6 of the 7 patients in the Denture group. However, one subject changed to medium

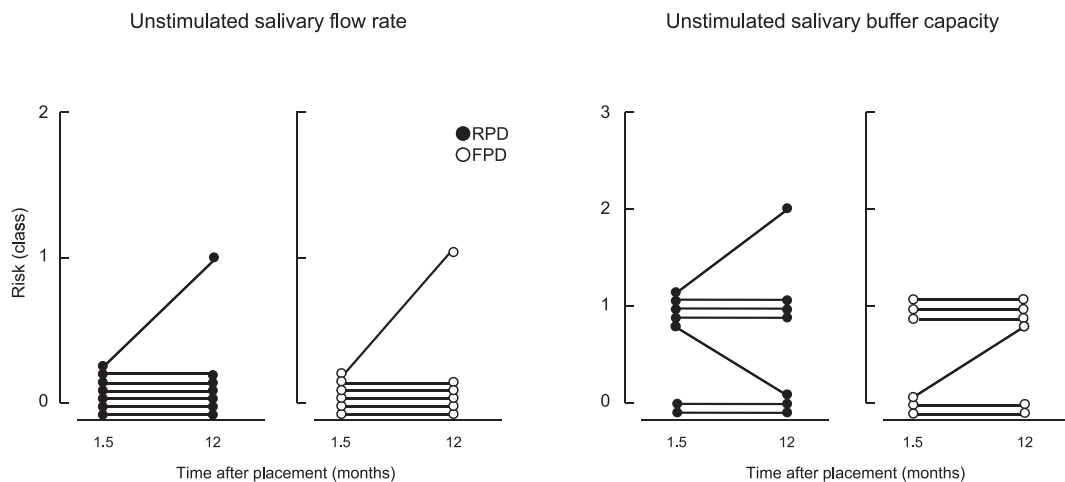


Fig. 1 Change in oral environment risk during prosthetic treatment for unstimulated salivary flow rate and buffer capacity. RPD : Removable partial denture, FPD : Fixed partial denture.

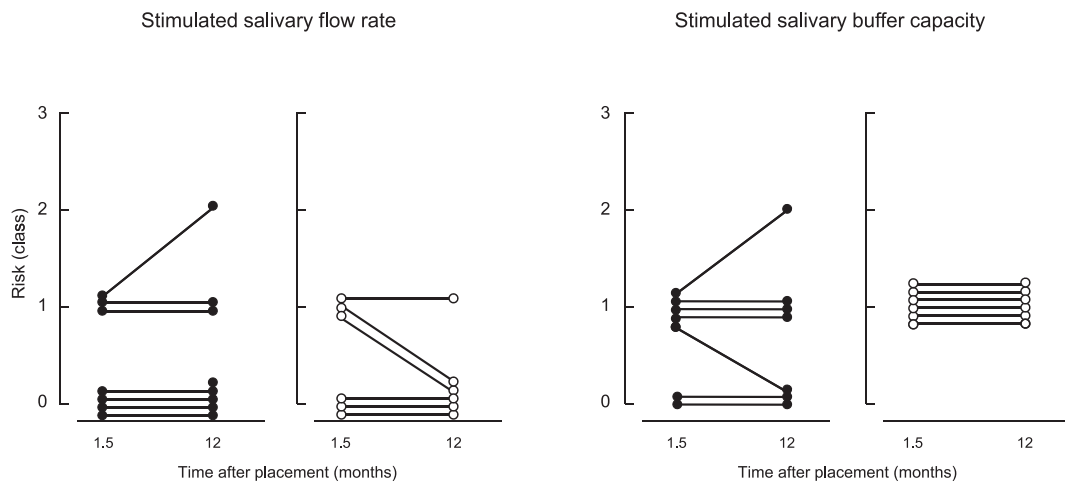


Fig. 2 Change in oral environment risk during prosthetic treatment for stimulated salivary flow rate and buffer capacity.

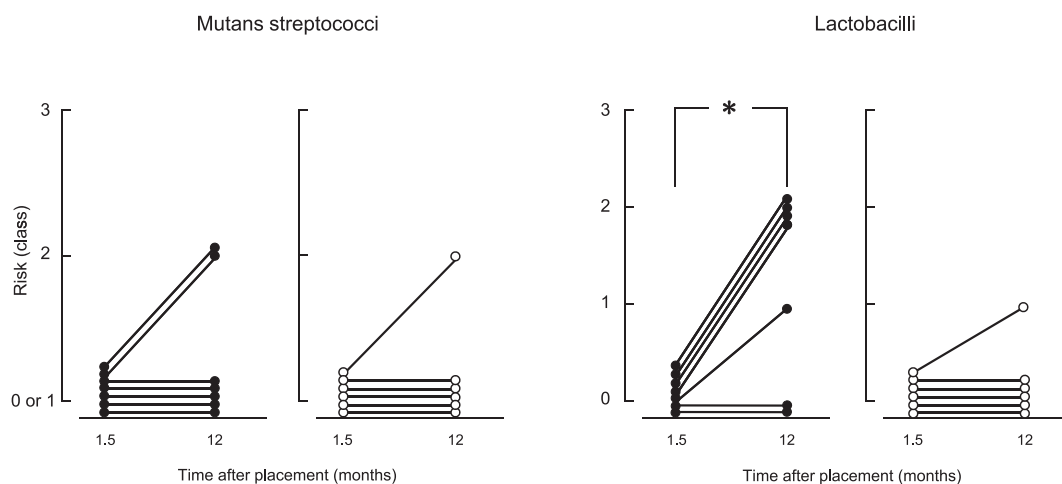


Fig. 3 Change in oral environment risk during prosthetic treatment for mutans streptococci and lactobacilli (* : $p < 0.05$).

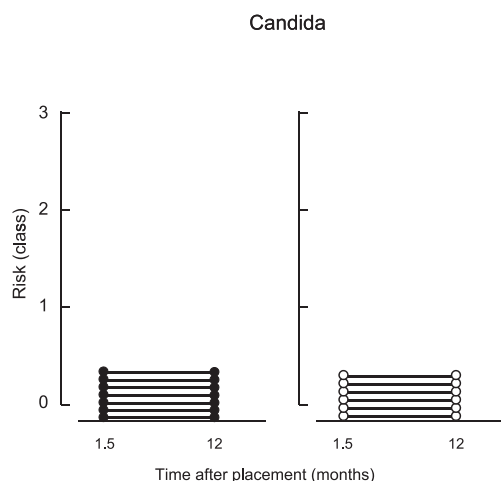


Fig. 4 Change in oral environment risk during prosthetic treatment for Candida.

risk. On the other hand, no risk changes were noted in any of the subjects in the Dentate group. No significant differences were noted between the two groups.

Figure 3 and 4 show changes over time for stimulated SM, LB and CA after completion of the prosthetic treatment. Changes over time in the number of SM were noted in 2 of the 7 subjects in the Denture group, while 1 of the 6 subjects in the Dentate group showed any risk change. No significant differences were noted in either group. As for changes over time in the number of LB, low risk in 4 of the 7 subjects in the Denture group turned to high risk. Although they had a class 0 risk at baseline, 4 of them increased to

class 2 at follow-up. Wilcoxon's signed rank test revealed that there were significant increases in the number of LB one year after placement of the dentures. In contrast, no changes in the number of LB were noted in the Dentate group. There was no change in either group with respect to the risk for CA.

DISCUSSION

Study design

For this study we selected as subjects elderly who received their first removable dentures and had low caries risk. The incidence of systemic diseases increases with age, which influences the oral environment. Furthermore, caries risk increases with decreases in the amount of saliva and increases in the number of microbes. Therefore, changes in caries risk in the elderly should be followed over time. We focused on patients who were wearing their first removable dentures because the previous cross-sectional study reported differences in the oral environment between patients with fixed prostheses and those with removable dentures.³ That study revealed that the number of the cariogenic bacteria SM and LB was greater in subjects with removable partial dentures than in those with fixed prostheses, indicating that the natural teeth of the partial denture wearers were exposed to a high caries risk. However, the results of that study did not make it clear when the number of bacteria increased in the patients with removable den-

tures, before or after the placement. Therefore, our present study was designed to follow up the changes that occurred over time in patients who were wearing their first partial dentures and who initially had low caries risk.

Results

Saliva has the important role of providing protection against caries.⁷ The reduction of salivary flow that accompanies aging causes various problems in the oral cavity, including alteration of oral microflora.² The reduction in the unstimulated salivary flow rate that is associated with aging contributes to increased caries incidence.⁸ We found no changes in the stimulated salivary flow rate after denture placement. The subjects had no systemic diseases that decreased their saliva volume, and reported no regular use of medications. It has been reported that although saliva secreted from the submandibular and sublingual glands temporarily increases after placement of new dentures, the volume returns to normal in 30 to 150 days.⁹ In our study, the stimulated salivary flow rate decreased in one subject compared with that at baseline. It seems that removable dentures do not significantly affect this factor. No significant differences were noted in the Dentate group either. They maintained low caries risk one year after the fixed prostheses were cemented.

The buffering capacity of stimulated saliva varies with the amount of saliva. When the salivary flow rate decreases, bicarbonate in the saliva decreases. Buffer capacity is an important factor in caries risk. The subject whose risk increased to moderate one year after denture placement also had decreased saliva. In this case, increasing the saliva may be the only way to reduce the risk. It has been reported that improving the ease of masticatory movements will increase the number of masticatory strokes, which may result in an increase in the amount of saliva.^{10,11} In this study, no changes were noted and low caries risk was maintained in the Dentate group.

SM usually is introduced in childhood by vertical infection from the mother.^{12,13} Once established, it is difficult to exclude from the mouth. Patients with caries risk before placement of the dentures were selected

as the subjects in this study. However, the risk increased in two of the subjects at follow up, which may have been caused by a decrease in the amount of saliva. The decrease may induce the accumulation of denture plaque and an increase in the number of SM in the biofilm. Furthermore, the increase in SM contributes to caries development in the remaining teeth, in particular teeth with clasps, because of poor oral hygiene. No caries were noted in the Denture group in this study after one year of follow up. However, it has been reported that the number of SM does not decrease even after caries is treated.¹⁴ Therefore, it is important to follow up whether the number of SM increases in denture wearers. Unlike SM, LB have no strong capacity to adhere to smooth tooth surfaces. However, it has been reported that LB are significant in caries prevalence because they are frequently detected in uneven regions of teeth, such as pits, fissures and carious lesions.^{15,16}

The bacterial content increased after one year in almost all of the subjects who participated in this study. Parvinen reported in his comparison study that the number of LB was significantly higher in subjects with complete dentures than that in dentate subjects.¹⁷ LB adhere to rough surfaces, and acrylic resin denture surfaces are rougher than metal or natural teeth. Therefore, dentures may offer a good environment for bacteria. The presence of LB in edentulous subjects suggests that the denture is rough and easily accumulates bacteria. Another report noted that LB may coexist with SM which is in the center of the biofilm. However, caries-inducing SM did not increase in any of the subjects participating in this study one year after placement. Therefore, there may not be a direct relationship. Other factors than denture placement may contribute to the increased number of LB. There are different varieties of LB in terms of genetic make up, and the genotypes of LB may differ in saliva and in caries. Some types of LB may be transmitted through food and other vectors, making it easy for them to establish a foothold in the oral cavity. In any event, LB produce lactic acid, and live in an acidic environment of less than pH 5.5. The reduced pH causes dental caries. It is uncertain whether the increase in the number of LB is caused by the denture material, ill-fitting

dentures, clasps, or a lack of oral hygiene. Our results indicate that dentures may contribute to caries because of the increased risk that accompanies their placement. In addition, we concluded that fixed prostheses may not increase the number of LB because no changes were noted in the oral environment of the Dentate group who maintained a low caries risk after treatment with fixed prostheses.

CONCLUSION

We studied subjects with low caries risk at their initial placement of removable and fixed prostheses, comparing their oral environment at 1.5 and 12 months to investigate the changes over time. Significant increases in the number of lactobacilli were noted in the Denture group one year after denture placement, while no changes were noted in any factors in the Dentate group. This study indicated that placement of removable dentures changes low caries risk to high as a result of changes in the number of lactobacilli. Therefore, future investigations should be done on how to reduce the caries-inducing effect of denture placement.

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