Clinical significance
This clinical report describes the effect of prosthodontic treatments on the oral environment by using saliva test. The results suggest that the treatments decreased the amount of cariogenic bacteria and enhanced resistance to caries.

Abstract
Patients: A 55-year-old woman with complaints of esthetic disturbance and masticatory dysfunction visited Osaka Dental University Hospital. The remaining upper teeth showed severe degradation of the coronal dentine because of caries. Additionally, the vertical stop in the molar region was lost. In the initial treatment, an overdenture was placed for urgent improvement of the chief complaint. We diagnosed the patient as having esthetic disturbance and masticatory dysfunction due to many decayed and missing teeth. Subsequently, we performed oral surgical, endodontic, and periodontal treatments of the remaining teeth based on the diagnosis. According to the patient’s request, fixed prostheses, i.e., crowns and fixed partial dentures, were selected as the final prostheses.

On the other hand, since caries progression is possible during a long-lasting treatment, the patient’s oral environment has been monitored using a saliva test to estimate caries activity. We selected the following 4 factors as the oral environmental factors: the stimulated salivary flow rate, buffering capacity, and salivary microbial counts of mutans streptococci and lactobacilli. The first examination revealed a high-risk oral environment. However, lactobacilli counts decreased immediately after the cementing of fixed prostheses and were low-risk at recall. Other factors remained at low-risk levels throughout the treatment period.

Discussion: To improve esthetic disturbance and masticatory dysfunction, prosthetic treatment was performed, and the progressive degradation of tooth structures due to caries was prevented. The oral environment was examined by the saliva test during therapy. After the treatment, the lactobacilli counts decreased. This is thought to be the result of removing caries and poorly fitting restorations.

Conclusion: By means of the saliva test, we confirmed the improvement in the oral environment following proper prosthetic treatment.

Key words: saliva, dental prostheses, dental caries activity tests

Introduction
Prosthetic treatment is a definitive treatment for dental care. However, most prostheses do not last for a long time and patients might encounter various difficulties. The common reasons for the failure of prosthesis are dental caries and periodontal disease.1-3

In the past, restorative treatment for caries involved only caries removal through treatment. However, the process underlying caries incidence has been paid considerable attention recently. The planning, treatment, and follow-up can be precisely determined by identifying the cariogenic factor. Therefore, restorative treatment should not only achieve the recovery of jaw functions but also help in the resistance of the oral environment against secondary caries.

In this case, using the saliva test, we longitudinally investigated the effects of prosthodontic treatment on the oral environment in a patient whose occlusion was markedly disturbed by caries.
Outline of the case

1. Medical examination and clinical examination finding

A 55-year-old woman with no systematic disease visited our university hospital in July 2001. She complained of esthetic disturbance and masticatory dysfunction. The patient’s condition worsened over several years, but the caries were left untreated because she disliked the sound of dental machines. Recently, she decided to opt for treatment since she experienced difficulty during eating.

The examinations of the remaining teeth using an explorer revealed that the degradation of tooth structures had progressed to the subgingival region of teeth 12, 14, 16, 17, 26, and 36 (FDI). On the other hand, the degradation of coronal dentine was found in teeth 11, 13, 15, and 21-25 (Fig. 1). All these teeth were tested non-vital. At teeth 44 and 45, poorly fitting crowns were cemented, and secondary caries was found in the crown margin.

Examination of the teeth using maxillary and mandibular diagnostic casts revealed no vertical stop in the molar region. Radiographic examination revealed a slight vertical absorption of alveolar bone in all regions (Fig. 2). Periodontal examination revealed pockets in teeth 11, 13, 15, 21-25, 31-35 and 41-47, with the depths ranging from 2 to 4 mm. Flare and swelling were noted in all gingival regions around the remaining teeth, and slight adhesion of plaque was also noted.

2. Diagnosis and treatment planning

In the initial treatment, the teeth that were estimated to have completely lost their function were extracted with the consent of the patient. Further, an overdenture was placed for immediate aesthetic recovery and occlusal reconstruction.

Periodontal treatment was provided because mild-to-moderate periodontitis was found. Further, endodontic treatment was performed for the non-vital teeth.

After the endodontic and periodontal treatments, the treatment denture was modified to suit the preparatory treatment using prostheses for the remaining teeth. Crowns and fixed partial dentures were selected as the final prostheses because these sites were applicable to fixed prostheses and the patient preferred to retain her jaw function without using removable dentures.

Endodontically treated teeth were temporarily cemented for provisional restorations after the abutments were fitted. The final fixed prostheses were planned to be cemented after follow-up observation.

Since the treatment period had extended for a long term, the patient’s oral environment required be monitored using the saliva test to estimate caries activity. We selected the following 4 factors as oral environmental factors: stimulated salivary flow rate, buffering capacity, and salivary microbial counts of mutans streptococci (SM), and lactobacilli (LB). These were determined by the saliva tests performed using the Dentocult® series (Orion Diagnostica, Helsinki, Finland).

The stimulated saliva was collected while the patient chewed 1 g of paraffin wax for 5 min. The volume was measured directly from the tube, and the flow rate (ml/min) was calculated. The buffer capacity of the stimulated saliva was determined using Dentobuff Strip®. The data were divided into 3 levels according to a model chart (Table 1). After culturing with Dentocult SM and Dentocult
LB, the SM and LB counts were determined by comparing with a model chart. The results were classified into 4 groups (Table 1). Standard criteria were established in order that the risk level of oral environmental factors determined by the saliva test increases (+) as an indication of an increase in the risk of development of caries.

### 3. Clinical courses

The medical examinations were performed at the first visit in July 2001 (Fig. 3A). Based on these data, teeth 12, 14, 16, 17, and 26 with poor prognosis were removed and the overdenture was replaced. Endodontic treatments were performed for teeth 11, 13, 15, and 21-25, while the patient was wearing dentures, whereas periodontic treatments were performed for teeth 11, 13, 15, 21-25, and 41-47. In March 2002, each metal core was cemented one by one at the site for which endodontic treatment was completed (Fig. 3B).

In August 2002, provisional restorations were positioned at teeth 11, 13, 15, 21-25, and 27 to remove the denture. Four months after the cementation of provisional restorations, adjustment and modification could be performed to verify the aesthetic and functional improvement (Fig. 3C). In June 2003, fixed prostheses were cemented provisionally. In October, functional jaw movements as well as periodontic and aesthetic factors were satisfactory; therefore, all fixed prostheses were cemented definitively (Fig. 3D). When we recalled the patient after 1 year of the cementing (Fig. 3E), she had no complaint and the prostheses were favorable from aesthetic and functional viewpoints.

### 4. Time-course changes in results of the saliva test

Table 2 showed time-course changes in results of the saliva test. The saliva test was carried out at each step of treatment from the first visit to the recall. As shown in Fig. 3A, the saliva test at the first visit showed that the risk level for caries was moderate as indicated by the stimulated salivary flow rate, but it showed high risk levels when the salivary buffer capacity, SM, and LB counts were high. This indicated that the patient was at a very high risk for caries. The risk levels of these environmental factors were all high when the patient was wearing a treatment denture (Fig. 3B). The risk levels indicated by the stimulated salivary flow rate and its buffer capacity tended to decrease after wearing the provisional restorations for 4 months (Fig. 3C), but
those indicated by the SM and LB counts did not improve. The test performed immediately after the wearing of fixed prosthesis (Fig. 3D) showed that the LB counts decreased, and the risk level remained low at recall (Fig. 3E). There were no changes in the risk levels indicated by other factors.

Discussion

1. Treatment of caries
Caries are generally treated by removing them, followed by the use of restorative materials. Since the risk for caries is thought to greatly depend on the amount of cariogenic bacteria, the oral environment factor can be estimated by the saliva test.\(^6,7\) In the present case, it appeared indispensable to recover functional maintenance through the restorative treatment and clarify cariogenic factors because the patient had many caries.

2. Time-course changes in oral environment
Time-course changes in the oral environment were investigated during the period from the first visit to recall, but the total risk assessed for the present patient was only slightly decreased in this period. The stimulated salivary flow rate was steady throughout the period, and it was lower than the normal value; therefore, the risk level for caries as indicated by the salivary flow rate was moderate. It has been reported that the salivary flow rate varied depending on the amount of drugs regularly taken, occlusal force, and the number of mastication cycles.\(^8-11\) The patient in this case report took no drug regularly; therefore, we considered that the masticatory efficiency was increased by the reconstruction of occlusion. However, the result indicated that there was no increase in the salivary flow rate. Salivary nuclei are excited by mechanical stimulus. Wolff reported that new dentures acted as an additional mechanical stimulus to the salivary reflexes, thus increasing the flow rate.\(^12\) However, the rate decreased to normal levels after several weeks. In this patient, the sharp dentine resulting from the caries might act as a mechanical stimulus. For this restricted case, it is difficult to confirm whether the mechanical stimulus is related to an increase in the saliva flow rate.

The amount of saliva increases when the parasympathetic nervous system is in a relaxed state. Therefore, stress level affects the salivary flow rate. However, the status of dentition with degradation of coronal dentine may be correlated with her stress. Since based on the date obtained we cannot confirm whether stress increased the salivary flow rate in this patient, it is necessary to collate information on similar cases together with the respective saliva data in the future.

An increase in the salivary flow rate results in a high bicarbonate content. Therefore, the risk level of SM remains moderate in respect of buffering capacity, which depends on the salivary flow rate.

The risk level of SM remained high during the test period. It has been known that SM infection occurs exogenously soon after birth and SM adhesion to teeth is very strong. Therefore, it is difficult to expel SM from the mouth through life. This might explain why in the present case, there was little change in the SM counts. It is very likely that if the risk level for caries as indicated by the SM counts remained high, the patient would continue to constantly suffer from caries. Bacterial elimination using chlorhexydine has been reported to be effective in reducing SM counts.\(^7,13\) However, this method involves complications related to allergic response and microbial substitution. These cannot be solved yet. With regard to this case, it appears difficult to lower a high risk level of SM.\(^14\)

On the other hand, the LB counts were reduced by the restorative treatment. LB is a
bacterium that increases with the progression of caries. LB is often detected in a poorly fitting restoration and a deep region of caries. The present patient had many cavities and the risk level of LB was high at the first visit. LB counts were difficult to decrease during the cementing of provisional restorations. After crowns and fixed partial dentures were selected and cemented as the final prostheses, the LB counts were remarkably decreased. The low risk level of LB persisted till recall.

Although it has been reported that oral environment can be changed by treatment for approximately 3 months, the oral environment in the present case was only slightly changed after as long as nearly 2 years from the first visit for cementing provisional restorations. LB tends to adhere to the partial denture. Morinushi reported that the LB counts in children decreased significantly at a week after a restorative treatment for caries. Further, Wright found that LB counts were reduced significantly by treatment for approximately 5 months. However, the LB counts did not decrease after removing caries cavities in this case. The frequency of meals is considered to be one of the reasons for this. This patient had a high frequency of consuming snacks between meals, which did not decrease during the treatment. Moreover, LB counts are affected by the use of removable dentures and provisional restoration. In the present case, decrease in LB counts may have been inhibited because acrylic resin was used for the removable denture and the provisional restoration. However, it appeared that the LB counts would have decreased because of improved fitting to the marginal region and the smooth metallic surface of the final prostheses. The saliva tests performed repeatedly with the progression of caries treatment were useful to estimate the changes in the oral environment and caries risk. Since high-risk factors continued to be present even at recall, it was necessary to continue support treatment.

**Conclusion**

The results of the saliva tests demonstrated that the oral environment could change with the progression of prosthodontic treatment. If risk factors for caries are further improved, prostheses would be retained well more easily, and the patient’s QOL would be further improved.

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**References**


