

---

## CASE REPORTS

---

# A case report of quantitative evaluations of prosthetic treatments using glucose elution amount

UNO MITSUNORI<sup>1)</sup>, HIGA TASUKU<sup>2)</sup>, KAWAI RYOSUKE<sup>1)</sup>, OMORI TOSHIKAZU<sup>1)</sup>,  
KITAGO MITSUNOBU<sup>3)</sup>, KURACHI MASAKAZU<sup>4)</sup>, ISHIGAMI HAJIME<sup>1)</sup>

*The inclusion of masticatory function tests for patients with dentures under medical insurance has now made it possible to conduct function tests based on patient opinion and dentist experience, from the prosthetic diagnosis and treatment stages through post-treatment evaluation.*

*Denture satisfaction depends on the patient's subjective opinion. In this case, fabricated dentures were evaluated using the indices of glucose elution amount and occlusal contact area at three time points; before and after wearing the denture and three months after wearing the denture.*

*The glucose elution amount increased approximately 3-fold three months after wearing the dentures, compared to the amount before denture wear. In addition, the occlusal contact area increased about 2.5-fold three months after wearing the dentures, compared to before denture wear. Furthermore, there was a significant positive correlation between the glucose elution amount and occlusal contact area, with a correlation coefficient of 0.84 ( $p=0.005$ ). Qualitative evaluation of the occlusal relationship was possible with images of occlusal contact using the Dental Prescale<sup>®</sup> system.*

*The above findings suggest that glucose elution and occlusal contact area measurements may enable the quantitative evaluation of the masticatory function of fitted dentures.*

Key words : prosthetic treatment, glucose, Dental Prescale<sup>®</sup> system, quantitative evaluations

## Introduction

It is essential to formulate a treatment policy based on POS (Problem-Oriented System)<sup>1)</sup> for patients who have lost teeth due to tooth root fracture or periodontal disease, considering the condition of the remaining teeth and the alveolar ridge.

Here, a patient who wore dentures at  $\overline{567}$  developed masticatory disturbance after tooth extraction due to the root fracture of  $\overline{76}$ . A new denture was fitted for  $\overline{76|\overline{567}}$  to resolve this issue, and the patient was satisfied after dentures were used as prosthodontic treatment for the missing teeth.

The authors measured the glucose elution amount and occlusal contact area by the patient who chewed

gummy jelly with a denture that was fabricated to improve masticatory function at three points in time, before and after wearing the denture and three months after wearing the denture, to quantitatively evaluate masticatory function.

## Case summary

Patient: 59-year-old man

Date of first visit: June 10 2020

Main complaint: Masticatory disturbance due to extraction of  $\overline{76}$

Medical history: Diabetes, hyperthyroidism

History of current condition:  $\overline{76}$  were extracted at the dental and oral surgery department of another hospital. The patient did not wear the denture

---

<sup>1)</sup>Department of Prosthodontics, Division of Oral Functional Sciences and Rehabilitation, Asahi University School of Dentistry.  
1851 Hozumi Mizuho-city Gifu Japan 501-0296

<sup>2)</sup>Senior resident of Asahi University Medical and Dental Center  
1851 Hozumi Mizuho-city Gifu Japan 501-0296

<sup>3)</sup>Department of Periodontology, Division of Oral Infections and Health sciences, Asahi University School of Dentistry  
1851 Hozumi Mizuho-city Gifu Japan 501-0296

<sup>4)</sup>Asahi University  
1851 Hozumi Mizuho-city Gifu Japan 501-0296  
(Accepted January 7, 2021)

fabricated at  $\overline{567}$  a number of years ago by the patient's local dentist, as the denture was ill-fitting. Current symptoms: The patient's facial appearance had no deviation of the chin, but the corner of the mouth drooped to the right. Examination of the temporomandibular joint (TMJ) revealed no TMJ clicking, and no spontaneous pain or tenderness of the TMJ or masticatory muscles. The patient habitually chewed on the right side.

Intraoral findings (Fig.1) showed that  $\overline{76|567}$  were

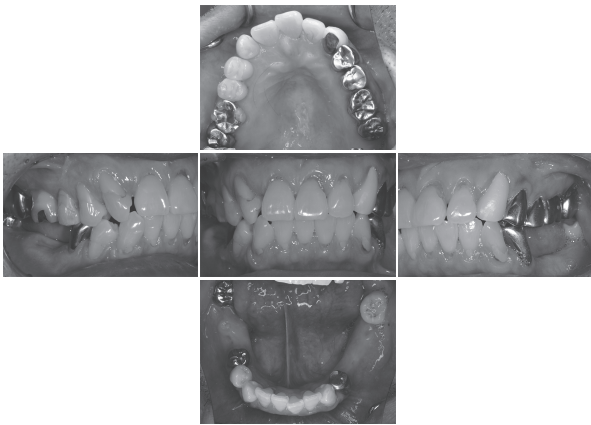


Fig.1 Intraoral photograph at the first visit

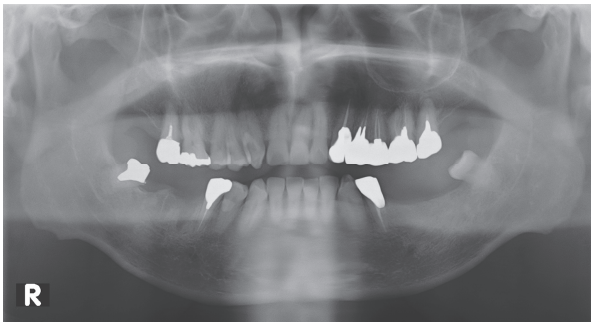


Fig.2 Panoramic Radiography photograph at the first visit

missing, and cervical caries were found at  $\overline{31|12}$ . The condition of the teeth corresponded to Kennedy classification class III and Eichner classification A2. The patient also had poor oral hygiene. The partial denture ( $\overline{567}$ ) worn at the first visit was poorly maintained and unstable, and there was attrition of the artificial tooth. A mucosal surface compatibility test confirmed the obvious ill-fit of the denture.

Panoramic radiography (Fig.2) revealed bone healing failure at  $\overline{76}$  and mild bone resorption in bilateral mandibular molar areas. A detailed periodontal examination (Fig.3) showed that tooth mobility was 4 mm or less throughout the entire jaw, which is within the range of physiological mobility, but there was gingival swelling and bleeding on probing. However,  $\overline{8|8}$  had a probing depth of  $\leq 6$  mm, and tooth mobility was 1.

Diagnosis: The patient was diagnosed with masticatory disturbance due to an ill-fitting mandibular denture and tooth loss. Evaluation of the partial loss based on the Japan Prosthodontic Society disease classification<sup>2)</sup> indicated that the difficulty level was Level II, at 67/100.

### Treatment content and Progress

#### 1. Treatment policy and plan

The characteristics of clasp dentures, Konus dentures, and implant abutment fixed prosthesis were explained to the patient as options for the prosthodontic device, and the patient selected a mandibular clasp denture. The mandibular denture for  $\overline{85|48}$  was fabricated using a combination clasp (Buccal: 0.9mm wire arm, Lingual: casting arm), casting lingual bar, and BioACE resin teeth (SHOFU, Tokyo). The metal used in the device was 12%-dental gold silver palladium alloy.

Mobility			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Bleeding																						
Probing	B		4	3	3	3	3	3	3	3	2	3	3	2	3	3	2	3	3	3	3	3
depth	L		3	4	4	5	3	3	2	2	3	3	2	3	3	3	3	3	3	3	3	4
Bleeding							+															
		8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8					
Bleeding		+																				
Probing	L	5	3	3	3	3	3	2	2	3	2	2	2	2	2	2	2	2	2	2	2	3
depth	B	4	4	6	4	3	3	3	3	3	2	3	3	2	2	3	2	2	2	2	2	3
Bleeding		+																				
Mobility		1			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	

Fig.3 Periodontal examination at the first visit

## 2. Treatment content

The treatment content used for this patient was as follows. First, a preliminary impression was taken to fabricate an individual tray. The position of the margins of the fabricated individual tray was determined while visually confirming and palpating the range of motion of the mucosa and tongue. Muscle trimming was performed by softening the compound for marginal shaping (PERI COMPOUND, GC, Tokyo) and performing functional movements with the mouth open and closed. Silicone impression material (Affinis, YOSHIDA, Tokyo) was used for the final impression. Registration of interocclusal relation was comprehensively determined using the postural rest position and facial measurements, referencing the old denture. The alignment of the artificial teeth was adjusted to ensure that the buccal cusp was mainly occluded. A mucosal compatibility test and occlusal adjustment were performed after the denture was fabricated. Fig.4 shows the intraoral photograph after wearing the denture. The patient said he found it much easier to eat with the denture than with the previous unilateral denture.

## 3. Method used to evaluate therapeutic effect

The glucose elution amount was measured and the masticatory function test was performed three times; before and after fabricating the denture and three months after wearing the denture, using a masticatory performance tester Glucosensor GS-II (GC, Tokyo) and the gummy jelly glucolumn (glucose-containing gummy) (GC, Tokyo). Each data was shown as mean

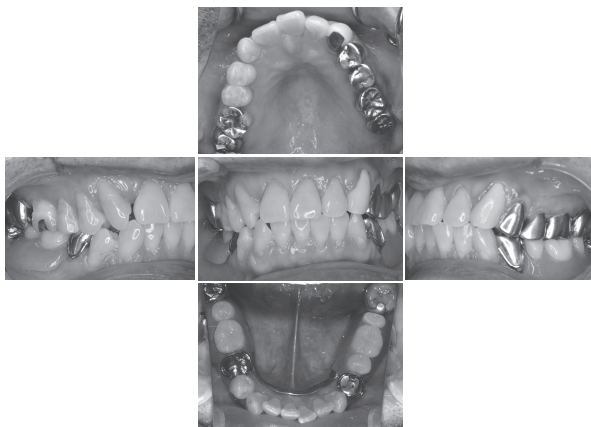


Fig.4 Intraoral photograph after wearing a denture

±SD. Dental Prescale II (GC, Japan) film was used for the occlusal force measurement system, and the Bite Force Analyzer (GC, Japan) occlusal force analysis software was used to measure occlusal contact areas and distributions, three times each, before and after denture fabrication and three months after denture wear. Each data was shown as mean ±SD.

We also examined the correlation between glucose elution amount and occlusal contact area. ESUMI EXCEL statistics Ver.7.0 (ESUMI Co, Tokyo, Japan) was used as the statistical software.

## 4. Glucose elution and Dental Prescale II measurement results

The fluctuations in glucose elution before and after wearing the denture and three months after wearing the denture are shown in Fig.5. The glucose elution values were before the denture ( $36.0 \pm 15.1$  mg/dL), after wearing the denture ( $87.0 \pm 16.5$  mg/dL) and three months after wearing the denture ( $104.0 \pm 8.4$  mg/dL).

The variation in the occlusal contact areas before and after wearing the denture and three months after wearing the denture are shown in Fig.6. The occlusal contact areas were before the denture ( $11.3 \pm 2.9$  mm<sup>2</sup>), after wearing the denture ( $21.8 \pm 2.3$  mm<sup>2</sup>) and

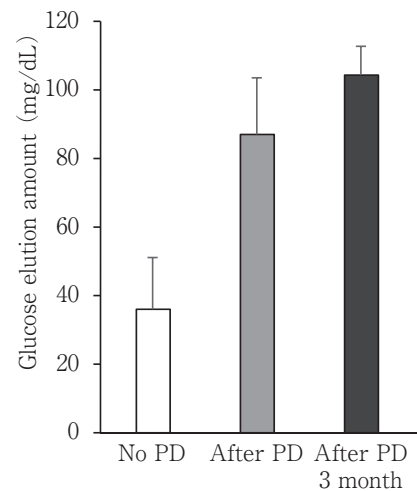


Fig.5 Glucose elution amount before and after wearing the denture and 3 months after wearing. No PD: It is not wearing a denture. After PD: It has been immediately after wearing a new denture. After PD 3 month: It has been three months since he wore a new denture. mean ±SD.

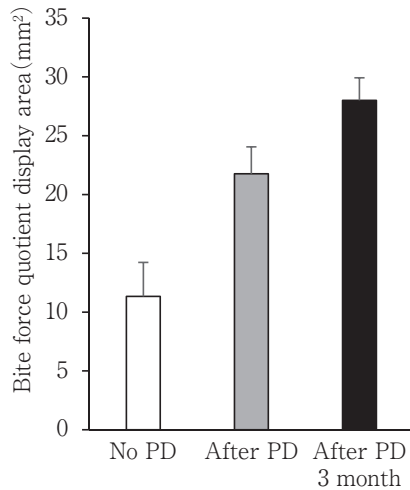


Fig.6 Occlusal contact area before and after wearing the denture and 3 months after wearing. No PD: It is not wearing a denture. After PD: It has been immediately after wearing a new denture. After PD 3 month: It has been three months since he wore a new denture. mean  $\pm$  SD.

three months after wearing the denture ( $28.0 \pm 1.9 \text{ mm}^2$ ).

Images of the occlusal contact area before wearing the denture and three months after wearing the denture, measured with Dental Prescale II, are shown in Fig.7. Before wearing the denture, predominantly, only the anterior teeth were occluded, but three months after wearing the denture, the entire jaw was evenly occluded, on both the left and right sides.

The correlation between glucose elution amount and occlusal contact area is shown in Fig.8, and a significant correlation ( $p=0.005$ , correlation coefficient 0.87) was found between the glucose elution amount

and occlusal contact area. The approximate straight line was  $y=4.15x-10.06$ , and the coefficient of determination was 0.84.

## Discussion

In this case, a partial denture was fitted for a patient with a masticatory disturbance due to a defect caused by tooth extraction. The authors measured masticatory efficiency using glucose elution amount to objectively evaluate the masticatory function of the fabricated denture and found that the masticatory function improved approximately three-fold three months after wearing the denture, compared to before the denture was worn.

Mastication is the process by which teeth grind food and mix it with saliva to produce a bolus suitable for swallowing. These processes are part of the digestive process and are thought to affect nutrition intake in humans.<sup>3)</sup> It has been reported that masticatory function is associated with health status of humans.<sup>4)</sup> Various previous studies have investigated the effect of the number of remaining teeth and the use of prostheses on masticatory function.<sup>5-7)</sup>

Traditionally, masticatory function has been evaluated with the sieving method using peanuts,<sup>8)</sup> almonds,<sup>9)</sup> carrots,<sup>10)</sup> or silicone<sup>11)</sup>. However, fine edible pieces become trapped in the embrasures of the remaining teeth, between the teeth, and in the margins of the prosthetic device. Alternatively, the masticated items are sometimes swallowed unconsciously and unintentionally. Therefore, there were concerns that the measurements may not be accurate.

However, it is possible to measure the glucose concentration after chewing glucose-containing



Before wearing the denture



3 months after wearing the denture

Fig.7 Occlusal contact status before and after wearing the denture

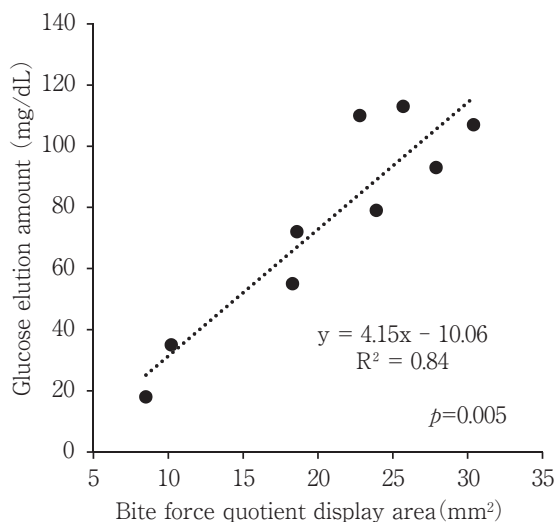


Fig.8 Correlation between glucose elution amount and occlusal contact area

gummy jelly.<sup>12)</sup> There have been many reports on studies measuring masticatory performance using gummy jelly as a test food.<sup>13-17)</sup> In this case, we also evaluated glucose elution after a gummy jelly was chewed for 20 seconds. The method for evaluating the glucose elution amount by chewing gummy jelly was as follows: After chewing the gummy jelly, 10 mL of pure water was taken into the mouth, then, the water and the crushed gummy jelly were expectorated into a filtration container, and the glucose was measured from the aqueous solution. Even if there was residual gummy jelly in the oral cavity, it had little effect on the measured values. This enabled stable data collection.

Masticatory function was also evaluated based on the occlusal contact area using the dental prescale. The occlusal contact area increased approximately 2.5-fold three months after wearing the denture, compared to the value before denture wear. After fitting the new denture, the denture was repeatedly adjusted to ensure the occlusal contact was even on both sides. As a result, a good occlusal contact relationship was qualitatively evaluated, as shown with the dental prescale.

There was a significant correlation between the glucose elution amount and the occlusal contact area. It is inferred that increased occlusal contact area improves masticatory efficiency. However, excessive increase in the occlusal contact area risks denture overturn and occlusal pain.

The clasp used in the design of the denture was not a rigid support with a cast clasp, but rather, a flexible support with a combination clasp that aimed to reduce the burden on the abutment tooth. The artificial tooth (resin) used for the molars resembles the anatomical morphology of teeth but is buccolingually narrower. Adequate occlusal adjustments were made during lateral movement, and the patient was cautioned to not generate jiggling force.

At present, about six months has passed since the final denture was fitted, and there have been no problems, such as denture base fracture, artificial tooth detachment, attrition, or mucosal surface incompatibility. The denture fit, occlusion, oral hygiene management, and other factors are evaluated during regular examinations.

In the future, we will also quantitatively evaluate jaw movement before and after wearing the denture.

### Conclusion

A treatment policy was formulated, and treatment was performed based on the problem-oriented system for this patient, to extract and solve problems in the oral cavity. Quantitative evaluation showed that glucose elution and occlusal contact area increased after wearing the denture. A patient was pleased with the new denture.

### Reference

- 1) Guven Y, Bal F, Issever H, Can Trosala S. A proposal for a problem-oriented pharmacobiochemistry course in dental education. *Eur J Dent Educ* 2014; 18: 2-6.
- 2) [http://www.hotetsu.com/files/files\\_149.pdf](http://www.hotetsu.com/files/files_149.pdf). Disease type classification manual 2016. [accessed 18. 05. 02].
- 3) Schimmel M, Katsoulis J, Genton L, Müller F. Masticatory function and nutrition in old age. *Swiss Dent J* 2015; 125: 449-454.
- 4) Miquel S, Aspiras M, Day JEL. Does reduced mastication influence cognitive and systemic health during aging? *Physiol Behav* 2018; 188: 239-250.
- 5) Izuno H, Hori K, Sawada M, Fukuda M, Hatayama C, Ito K, et al. Physical fitness and oral function in community-dwelling older people: a pilot study. *Gerodontology* 2016; 33: 470-479.
- 6) Kosaka T, Ono T, Kida M, Kikui M, Yamamoto M, Yasui S, et al. A multifactorial model of masticatory performance: the Suita study. *J Oral Rehabil* 2016; 43: 340-347.

- 7) Kikui M, Ono T, Kokubo Y, Kida M, Kosaka T, Yamamoto M, et al. Relationship between metabolic syndrome and objective masticatory performance in a Japanese general population: the Suita study. *J Dent* 2017; 56: 53–57.
  - 8) Manly RS. Factors affecting masticatory performance and efficiency among young adults. *J Dent Res* 1951; 30: 874–882.
  - 9) Renaud M, Mercier P, Vinet A. Mastication after surgical reconstruction of the mandibular residual ridge. *J Oral Rehabil* 1984; 11: 79–84.
  - 10) Tate GS, Throckmorton GS, Ellis 3rd E, Sinn DP. Masticatory performance, muscle activity, and occlusal force in preorthognathic surgery patients. *J Oral Maxillofac Surg* 1994; 52: 476–481.
  - 11) Olthoff LW, van der Bilt A, Bosman F, Kleizen HH. Distribution of particle sizes in food comminuted by human mastication. *Arch Oral Biol* 1984; 29: 899–903.
  - 12) Uesugi H, Shiga H. Relationship between masticatory performance using a gummy jelly and masticatory movement. *J Prosthodont Res* 2017; 61: 419–425.
  - 13) Ikebe K, Morii K, Matsuda K, Hazeyama T, Nokubi T. Reproducibility and accuracy in measuring masticatory performance using test gummy jelly. *Prosthodont Res Pract* 2005; 4: 9–15.
  - 14) Okiyama S, Ikebe K, Nokubi T. Association between masticatory performance and maximal occlusal force in young men. *J Oral Rehabil* 2003; 30: 278–282.
  - 15) Nokubi T, Nokubi F, Yoshimuta Y, Ikebe K, Ono T, Maeda Y. Measuring masticatory performance using a new device and beta-carotene in test gummy jelly. *J Oral Rehabil*. 2010; 37: 820–826.
  - 16) Nokubi T, Yasui S, Yoshimuta Y, Kida M, Kusunoki C, Ono T, et al. Fully automatic measuring system for assessing masticatory performance using beta-carotene-containing gummy jelly. *J Oral Rehabil*. 2013; 40: 99–105.
  - 17) Minakuchi S, Tsuga K, Ikebe K, Ueda T, Tamura F, Nagao K, et al. Oral hypofunction in the older population: position paper of the Japanese Society of Gerodontology in 2016. *Gerodontology* 2018; 35: 317–324.
-