

Original Article

Effect of denture adhesive on stability of complete dentures and the masticatory function

Sho Hasegawa, Toshiaki Sekita and Iwao Hayakawa

Section of Complete Denture Prosthodontics, Department of Masticatory Function Rehabilitation, Graduate School, Tokyo Medical and Dental University, Tokyo, Japan

This study examines the effects of denture adhesive on the retention and stability of complete dentures and the masticatory function. The authors estimated the stability of complete dentures from 3-dimensional (3-D) denture movement and rotational denture movement and additionally the masticatory function from cycle time and chewing time.

Six edentulous subjects who participated in this study had old and newly fabricated complete dentures. Upper denture movement was recorded using a 3-D motion capture system while chewing 3 kinds of food (peanuts, fish paste, raisins). Both the new and old dentures showed that using a denture adhesive contributes to reducing 3-D denture movement, rotational denture movement and chewing time during chewing the various foods. The cycle time in new and old dentures was statistically unaffected by applying denture adhesive. There was no statistically significant difference in improvement in 3-D denture movement or rotational denture movement between the new and old dentures, for any of the foods. This study observes the overall effect of denture adhesive during use for both dentures. The results of this study suggest that denture adhesive contributes to

reducing denture movement and so improves chewing function.

Key words: Denture adhesive, Denture movement, Complete denture, Mastication.

Introduction

Denture adhesives are used to improve the retention and stability of dentures in a large number of patients without any advice from dentists. In the United States, denture adhesives are used by more than 5 million denture wearers¹. Denture wearers mainly use denture adhesive to compensate for ill-fitting dentures as well as to alleviate discomfort.

It seems reasonable for denture wearers to use denture adhesives to enhance denture retention and stability. However, dental professionals are still undecided as to whether dentists should advise denture wearers to use them^{2,3,4}. Denture adhesives are classified according to manufacturing type, i.e., powder, paste, tape or cushion. Soluble denture adhesives such as the powder and paste types do not damage the soft tissues⁵. Tarbet and Grossman⁶ reported that 111 denture wearers who used a natural gum or a synthetic polymer adhesive for 6 months did not experience any increase in mucosal irritation of the denture-bearing tissues. On the other hand, insoluble denture adhesives such as the cushion type involve great risk of inducing alveolar ridge resorption^{5,7,8}. The ADA (American Dental Association) accepts some soluble denture adhesives, but the cushion type called the home-relin-

Corresponding Author: Sho Hasegawa

Section of Complete Denture Prosthodontics, Department of Masticatory Function Rehabilitation, Graduate School, Tokyo Medical and Dental University, 1-5-45, Yushima, Bunkyo-ku, Tokyo, 113-8549, Japan

Tel: +81-3-5803-5586

Fax: +81-3-5803-0214

E-mail: s.hasegawa.ore@tmd.ac.jp

Received June 4; Accepted September 12, 2003

er is not included. Soluble denture adhesive cannot be abused to the extent of changing vertical dimension, since they rapidly absorb water becoming gelatinous and spreading over the denture through chewing stress^{5,9}. Some studies indicate that denture adhesives improve denture retention and stability¹⁰⁻¹⁴. However there is little evidence of a positive correlation between the effect of denture adhesive and masticatory function.

This study 1) determines the effect of denture adhesive on reducing denture movement during mastication in new and old dentures by using the 3-D motion capture system, and 2) examines the influence of denture adhesive on chewing time for both dentures.

Materials and Methods

Subjects:

Six complete denture wearers, whose new dentures were fabricated at the dental hospital of Tokyo Medical and Dental University, volunteered to participate in this study, after giving informed consent. There were 4 male and 2 female subjects, from 71 to 77 years old and with a mean age of 73 years. The subjects were free from any signs or symptoms of craniomandibular dysfunction. Their dentures were replaced because they had complained to their dentist that their dentures were loose and uncomfortable. All subjects wore the newly fabricated dentures for at least 3 months. According to the method of Kapur¹⁵, the authors performed clinical evaluation and quantitative assessment of the denture-bearing tissues and the retention and stability of the subject's dentures. Tissue evaluations with a score of between 14 and 17 were regarded as satisfactory, those scoring below 14 were regarded as poor and those above 17 as good. The mean value of the subject's tissue evaluation was 14.3 (with a standard deviation of 1.4) in this study. Denture evaluations with a score of between 6 and 8 were regarded as fair, those below 6 as poor and those above 8 as good. In this study, the mean values of the new and old dentures evaluation were 9.5 (SD: 1.1) and 6.7 (SD: 1.1), respectively.

Measuring system:

The system of measuring denture movement consisted of a 3-D optical motion capture system with 2 infrared TV cameras (Elite system; Bio-engineering Technology & systems), a stereo photogrammetry (PGman; The Japan Society of Photogrammetry and

Remote Sensing) with a pair of 35 mm SLD cameras (NIKON F3; Nikon) and a personal computer (FMV-BIBRO NB7/80R; Fujitsu). The 2 infrared TV cameras were set up stereographically for measuring the 3-D movement of the maxillary denture and the mandible (Fig. 1).

The motion capture system can recognize multiple moving targets and calculate their 3-D coordinates in real time. The camera emits a synchronized flash from an infrared ray LED and detects the reflected light from the targets at a rate of 50 Hz. These targets with an infrared ray that reflect the membrane are hemispherical in shape and 2 mm in diameter. As for the accuracy of this motion capture system, maximum residuals were 0.10 mm in the coronal plane and 0.18 mm on the Anterior-Posterior axis¹⁶.

Twelve targets were prepared for each subject. Three targets were attached to the rim of the headgear to eliminate head movement, 3 targets were placed on a metal jig to measure upper denture movement, 5 targets were set on the inferior border of the nasal wing and the superior border of the external auditory meatuses to define the Camper's plane, and 1 target was set on the menton to measure the jaw movement (Fig. 2). The optical motion capture system cannot detect targets in the oral cavity because infrared rays cannot penetrate the oral cavity directly. So, a metal jig was attached to the incisal labial surface of the maxillary denture to measure the denture movement. This jig consists of 3 orthogonalized bars (projecting, horizontal and vertical) constructed of aluminum, 1.2 mm in diameter and 40 mm in length. Three targets were placed on the tips of the 3 bars. The influence on the retention and stability of the upper denture can be disregarded because the jig is too light (2.0 g in weight). The study is limited to the upper denture because it is difficult to attach a metal jig to the lower denture without affecting the muscles in the region of the menton and the upper central incisors, and to accurately separate lower denture movement from jaw movement.

To determine the relation between the coordinates of the external oral targets on the metal jigs and those on the dentures (the incisal point and the first molars were representative points), a stereo photogrammetry system (PGman) was used. The relation was represented by a transforming matrix, with which the loci of the 3 targets on the jig were transformed to the relative movements of the representative points on the maxillary denture to the Camper's plane.

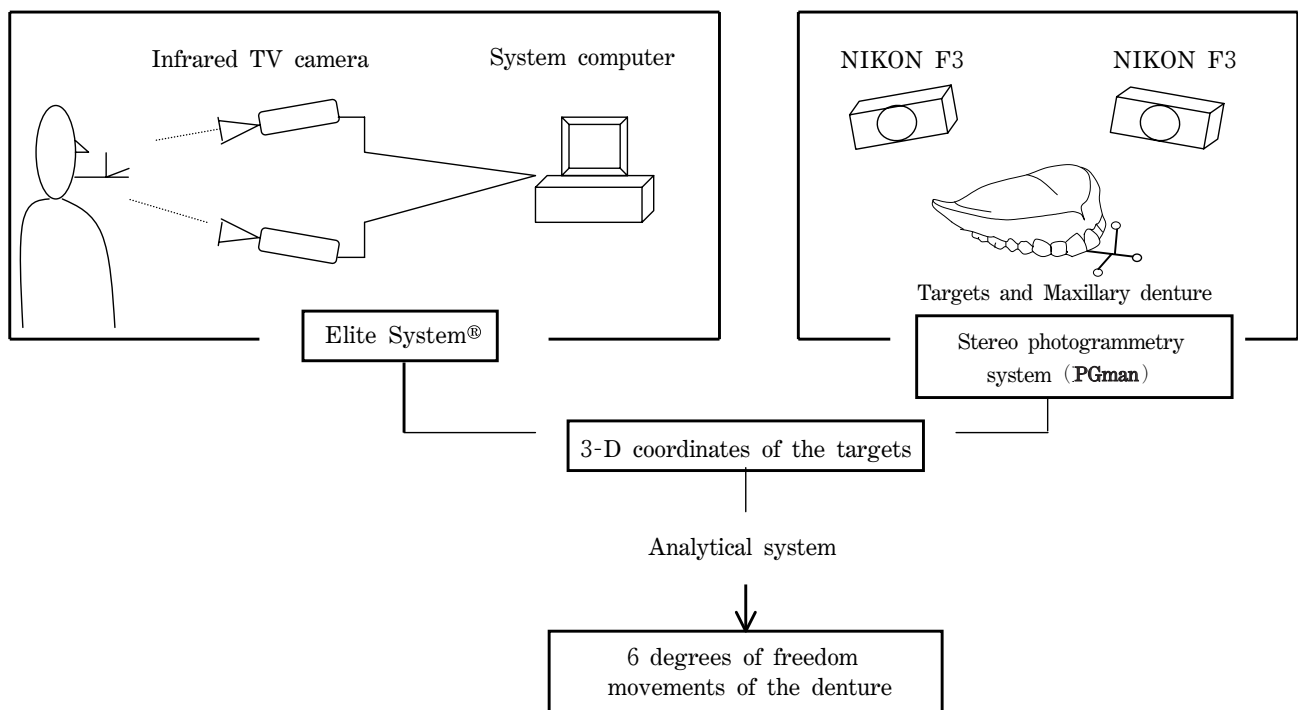


Fig. 1. Block diagram of the system.

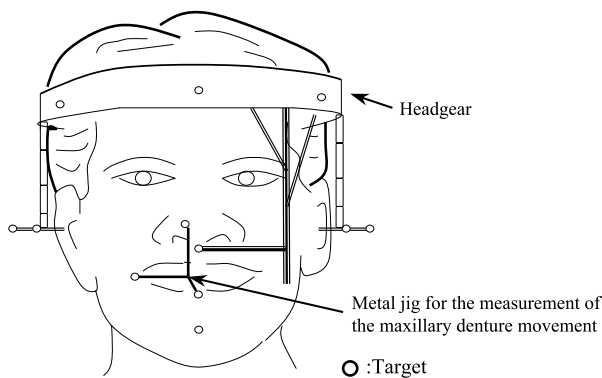


Fig. 2. Schema of the subjects in full face and positioning of targets. The metal jig (consisting of projecting, horizontal, and vertical bars) was attached to the labial surface of the front of the maxillary dentures. Three targets were placed on the tips of the metal jig to detect each target by the TV camera.

Denture adhesive application:

A paste type of denture adhesive was used in this study (Correct® Cream; Shionogi). The method of applying denture adhesive and the quantity followed written instruction. The 3 conditions of the denture adhesive were 1) no adhesive (Control), 2) adhesive applied to the upper denture (U), and 3) adhesive

applied to the upper and lower dentures (UL).

Denture movement and chewing function were measured for each condition and evaluated for each patient with the new and old dentures. A peanut, a square centimeter of fish paste and 2 raisins were used as test foods. First, the subjects were instructed to place each test food on their tongue. Second, they were instructed to masticate on the habitual side until the food was ready for swallowing. All subjects chewed on the right as the habitual side. The measurement was repeated 4 times with each food in each condition.

Data analysis:

Measurement data were recorded while the food was being chewed. The 3-D denture movement, rotational denture movement, cycle time and chewing time were analyzed. The chewing time was defined as the duration from the start of mastication to being ready to swallow. The denture movement and rotational denture movement that occurred during the middle 5 chewing strokes were chosen to assess them.

The denture movement consisted of vertical, lateral and anterior/posterior movement (Fig. 3). The rotational denture movements consisted of pitch, roll and rotation. The plane, containing 3 representative points

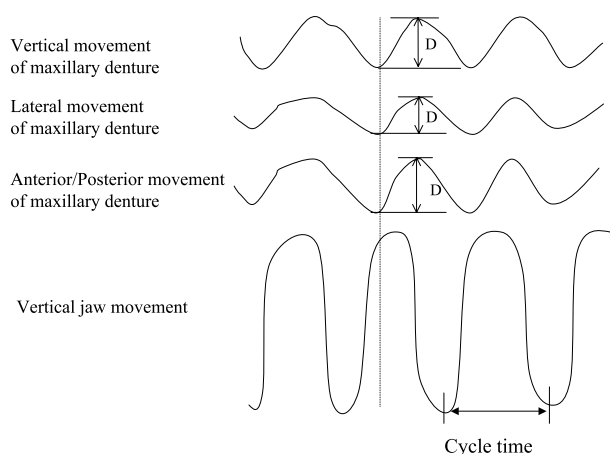


Fig. 3. Measure for the amount of denture mobility
D: the amount of the 3-D denture movement, Cycle time: duration from maximum opening to the next one.

(the incisal point and the first molars) on the upper denture, was defined as the upper occlusal plane (UP), and the centroid calculated with these points was defined as the centroid of the upper denture (CU). The normal vector of the upper occlusal plane was defined as the UP-vector. The vector directed from the CU to the upper incisal point was defined as the CUI-vector.

The UP-vector was used for calculating the amount of pitch and roll of the denture. The UP-vector spinning on the sagittal plane was defined as “pitch”. The UP-vector spinning on the coronal plane was defined as “roll”. The CUI-vector was used for calculating rotation. The CUI-vector spinning on the horizontal plane was defined as “rotation” (Fig. 4).

Paired t-test was used to determine the statistical significance of the difference in denture movement between the new and old dentures in the “Control” condition (no adhesive), and between the new dentures in the “Control” condition and the old dentures in the “UL” condition (applied to the upper and lower dentures). Those comparisons were carried out in order to examine whether the denture adhesive improve the denture movement of old denture up to the level of new denture wearing. Univariate analysis of variance was performed to determine the statistical significance of the difference in the denture movement and chewing data (cycle time and chewing time) of the 3 conditions applied to the denture adhesive. Two-way analysis of variance was used to determine the statistical significance of the difference in improvement in denture movement and rotational denture movement between the new and old dentures for each of the foods. We

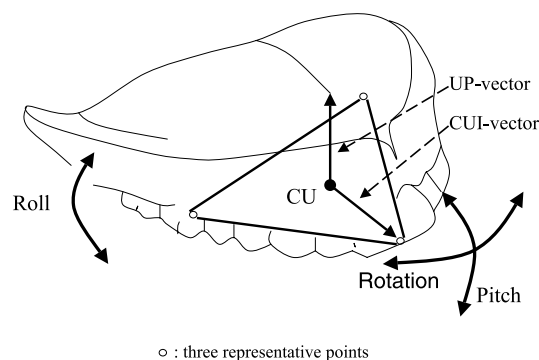


Fig. 4. Three rotational movement of the upper denture (Pitch, Roll, Rotation).

used the Bonferroni/Dunn method as multiple comparison. The significance level was set at 0.05. All statistical analysis was computed using the StatView statistical package (StatView® 5.0 ; SAS Institute Inc).

Results

Table 1 shows the amount of the denture movement while using the new dentures. Denture movement tended to decrease by applying denture adhesive. There were some significant reductions in denture movement in chewing the peanuts, fish paste and raisins.

Table 2 shows the amount of the denture movement during use with the old dentures. Denture movement tended to decrease by applying denture adhesive. There was a significant reduction in denture movement in chewing the raisins.

There were some statistically significant differences in the denture movement between the new and old dentures in the “Control” condition (Tab. 3), and the amount of denture movement between the new dentures in the “Control” condition and the old dentures in the “UL” condition showed no statistically significant difference.

Table 4 shows the amount of the rotational denture movement during use with both dentures. Rotational denture movement tended to decrease by applying denture adhesive. There were some significant reductions in rotational denture movement in chewing the peanuts and fish paste with the new dentures and the 3 foods with the old dentures.

There were some statistically significant differences in rotational denture movement between the new and

Table 1. The amount of denture movement during mastication with new denture (unit: mm)

Control: no adhesive, U: adhesive applied to the upper denture, UL: adhesive applied to the upper and lower dentures

		Peanut			Fish paste			Raisins		
		Control	U	UL	Control	U	UL	Control	U	UL
<u>1 1</u>	Lateral	0.99 (0.61)	0.55 * (0.19)	0.70 (0.40)	0.75 (0.34)	0.45 * (0.17)	0.58 (0.22)	0.78 (0.29)	0.52 * (0.24)	0.67 (0.50)
	Vertical	1.56 (1.55)	0.92 (0.55)	0.90 (0.45)	1.34 (0.96)	0.94 (0.53)	0.99 (0.71)	1.16 (0.72)	1.05 (0.74)	1.16 (1.02)
	Anterior/ Posterior	1.16 (0.81)	0.83 (0.44)	0.83 (0.62)	1.15 (0.78)	0.76 (0.42)	0.74 (0.51)	1.15 (0.71)	0.83 (0.44)	0.86 (0.59)
<u>1 6</u>	Lateral	0.86 (0.58)	0.62 (0.26)	0.66 (0.26)	0.75 (0.33)	0.56 (0.21)	0.60 (0.21)	0.71 (0.21)	0.63 (0.22)	0.68 (0.36)
	Vertical	1.02 (0.74)	0.79 (0.33)	0.72 (0.23)	0.91 (0.66)	0.72 * (0.26)	0.76 (0.46)	0.73 (0.26)	0.77 (0.33)	0.81 (0.58)
	Anterior/ Posterior	1.37 (0.72)	1.05 (0.47)	1.06 (0.59)	1.35 (0.85)	0.98 (0.49)	0.96 (0.58)	1.46 (0.76)	1.1 (0.49)	1.13 (0.70)
<u>6 </u>	Lateral	0.89 (0.58)	0.61 * (0.18)	0.65 (0.26)	0.73 (0.32)	0.52 * (0.17)	0.57 (0.22)	0.73 (0.19)	0.59 (0.21)	0.63 (0.33)
	Vertical	1.20 (1.16)	0.69 * (0.33)	0.65 * (0.21)	0.92 (0.57)	0.63 * (0.22)	0.66 (0.30)	0.77 (0.35)	0.77 (0.50)	0.79 (0.51)
	Anterior/ Posterior	1.41 (0.98)	0.95 (0.53)	0.93 (0.70)	1.17 (0.77)	0.73 * (0.37)	0.77 (0.53)	1.10 (0.67)	0.88 (0.54)	0.87 (0.64)

*P<0.05, significant differences from control

Mean
(SD)**Table 2.** The amount of denture movement during mastication with old denture (unit: mm)

Control: no adhesive, U: adhesive applied to the upper denture, UL: adhesive applied to the upper and lower dentures

		Peanut			Fish paste			Raisins		
		Control	U	UL	Control	U	UL	Control	U	UL
<u>1 1</u>	Lateral	1.30 (0.94)	0.94 (0.98)	0.81 (0.70)	1.26 (0.98)	0.90 (0.78)	0.92 (0.98)	1.56 (1.20)	0.96 (0.88)	0.91 * (0.55)
	Vertical	2.03 (1.62)	1.50 (1.22)	1.39 (1.24)	1.66 (1.23)	1.28 (0.85)	1.52 (1.29)	2.11 (1.43)	1.29 (1.19)	1.60 (1.18)
	Anterior/ Posterior	1.27 (0.54)	1.20 (1.08)	0.94 (0.54)	1.54 (1.12)	1.52 (1.63)	1.06 (0.84)	2.10 (1.61)	1.70 (1.77)	1.12 (0.64)
<u>1 6</u>	Lateral	1.77 (2.05)	1.39 (1.91)	1.18 (1.43)	1.69 (2.16)	1.29 (1.60)	1.35 (1.92)	2.08 (2.65)	1.39 (1.72)	1.21 (1.21)
	Vertical	2.53 (3.58)	1.78 (2.66)	1.76 (2.64)	1.95 (2.90)	1.57 (1.98)	1.92 (2.91)	2.47 (3.32)	1.76 (2.51)	1.78 (2.62)
	Anterior/ Posterior	1.77 (0.87)	1.80 (1.98)	1.40 (0.97)	2.28 (2.02)	2.32 (2.89)	1.61 (1.58)	3.11 (2.86)	2.60 (3.12)	1.68 (1.11)
<u>6 </u>	Lateral	1.45 (1.35)	1.12 (1.28)	0.98 (0.96)	1.36 (1.43)	1.02 (1.07)	1.07 (1.30)	1.63 (1.70)	1.11 (1.17)	1.00 (0.75)
	Vertical	1.85 (2.35)	1.34 (1.71)	1.39 (1.74)	1.46 (1.81)	1.17 (1.25)	1.36 (1.83)	1.79 (2.09)	1.32 (1.67)	1.33 (1.72)
	Anterior/ Posterior	1.37 (0.70)	1.31 (1.36)	1.01 (0.72)	1.74 (1.60)	1.73 (1.98)	1.13 (0.94)	2.17 (2.08)	1.89 (2.22)	1.16 (0.73)

*P<0.05, significant differences from control

Mean
(SD)

old dentures in the “Control” condition (Tab. 5), and the amount of rotational denture movement between the new dentures in the “Control” condition and the old dentures in the “UL” condition showed statistically significant differences in chewing the peanuts (Tab. 6).

There was no statistically significant difference in improvement in denture movement and rotational denture movement between the new and old dentures, for any of the foods (Two-way analysis of variance).

Figure 5 shows the cycle of time during chewing with the old and the new dentures. There was no statistically significant difference among the conditions of applying denture adhesive.

Table 3. Results of statistical analysis on the difference of the 3-D denture movement between the new and old dentures in the “Control” condition (Paired t-test)

New: new denture, Old: old denture

		New denture (Control)– Old denture (Control)		
		Peanut	Fish paste	Raisins
111	Lateral	N.S	N.S	New < Old *
	Vertical	N.S	N.S	New < Old *
	Anterior/Posterior	N.S	N.S	New < Old *
16	Lateral	New < Old *	New < Old *	New < Old *
	Vertical	New < Old *	New < Old *	New < Old *
	Anterior/Posterior	New < Old *	New < Old *	New < Old *
61	Lateral	New < Old *	New < Old *	New < Old *
	Vertical	N.S	N.S	New < Old *
	Anterior/Posterior	N.S	N.S	New < Old *

N.S; no significant

*P<0.05

Figure 6 shows chewing time with both dentures. With the new dentures, there were statistically significant differences between the Control and U, and between the Control and UL, in chewing the peanuts. With the old dentures, there were statistically significant

Table 5. Results of statistical analysis on the difference of the rotational denture movement between the new and old dentures in the “Control” condition (Paired t-test)

New: new denture, Old: old denture

	New denture (Control) – Old denture (Control)		
	Peanut	Fish paste	Raisins
Pitch	N.S	N.S	New < Old *
Roll	N.S	New < Old *	New < Old *
Rotation	N.S	N.S	New < Old *

N.S; no significant

*P<0.05

Table 6. Results of statistical analysis on the difference of the rotational denture movement between the new denture in the “Control” condition and the old denture in the “UL” condition (Paired t-test)

New: new denture, Old: old denture

	New denture (Control) – Old denture (UL)		
	Peanut	Fish paste	Raisins
Pitch	New > Old *	N.S	N.S
Roll	New > Old *	N.S	N.S
Rotation	New > Old *	N.S	N.S

N.S; no significant

*P<0.05

Table 4. The rotational movement of the upper denture during mastication with new and old dentures (unit: rad)

Control: no adhesive, U: adhesive applied to the upper denture, UL: adhesive applied to the upper and lower dentures

		Peanut			Fish paste			Raisins		
		Control	U	UL	Control	U	UL	Control	U	UL
New denture	Pitch	0.030 (0.021)	0.022 (0.015)	0.019 (0.011)	0.028 (0.020)	0.022 (0.015)	0.021 (0.017)	0.027 (0.017)	0.023 (0.017)	0.024 (0.020)
	Roll	0.020 (0.017)	0.012 * (0.004)	0.011 * (0.003)	0.013 (0.007)	0.009 (0.003)	0.011 (0.006)	0.012 (0.005)	0.012 (0.007)	0.010 (0.005)
	Rotation	0.021 (0.010)	0.015 * (0.005)	0.015 * (0.006)	0.015 (0.007)	0.010 * (0.005)	0.012 (0.005)	0.017 (0.008)	0.013 (0.006)	0.015 (0.010)
Old denture	Pitch	0.029 (0.016)	0.027 (0.018)	0.021 (0.009)	0.030 (0.016)	0.023 (0.011)	0.025 (0.012)	0.040 (0.023)	0.024 * (0.012)	0.030 (0.017)
	Roll	0.019 (0.006)	0.014 (0.009)	0.012 * (0.005)	0.017 (0.008)	0.013 * (0.004)	0.012 * (0.004)	0.022 (0.008)	0.012 * (0.004)	0.013 * (0.005)
	Rotation	0.018 (0.004)	0.014 * (0.007)	0.011 * (0.004)	0.017 (0.006)	0.009 * (0.004)	0.013 (0.007)	0.026 (0.012)	0.012 * (0.006)	0.015 * (0.011)

*P<0.05, significant differences from control

Mean
(SD)

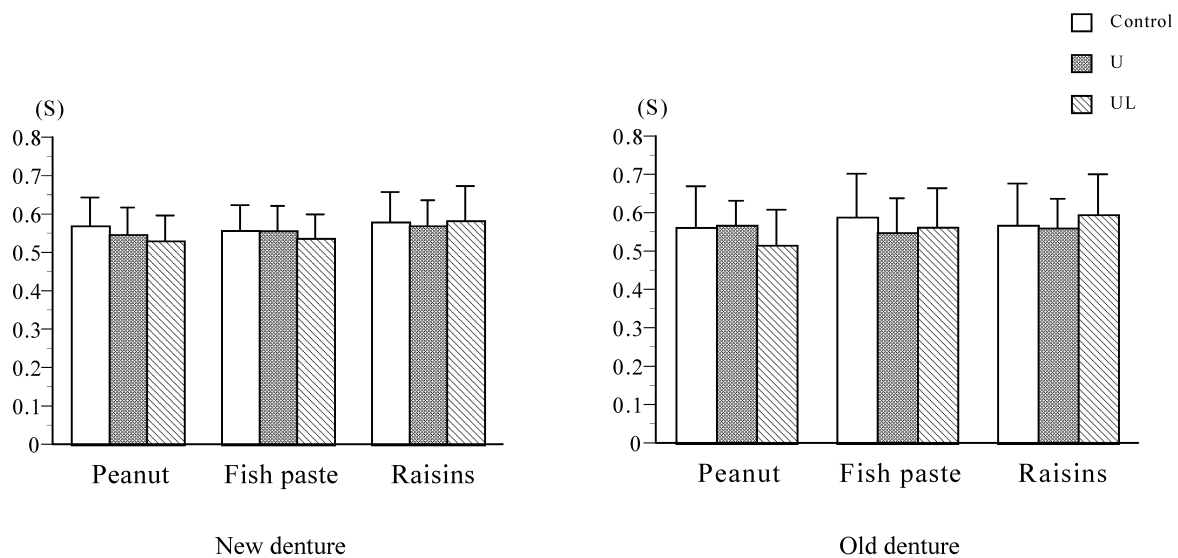


Fig. 5. The average values and their standard deviations of the cycle time during mastication.

Control: no adhesive, U: adhesive applied to the upper denture, UL: adhesive applied to the upper and lower dentures.

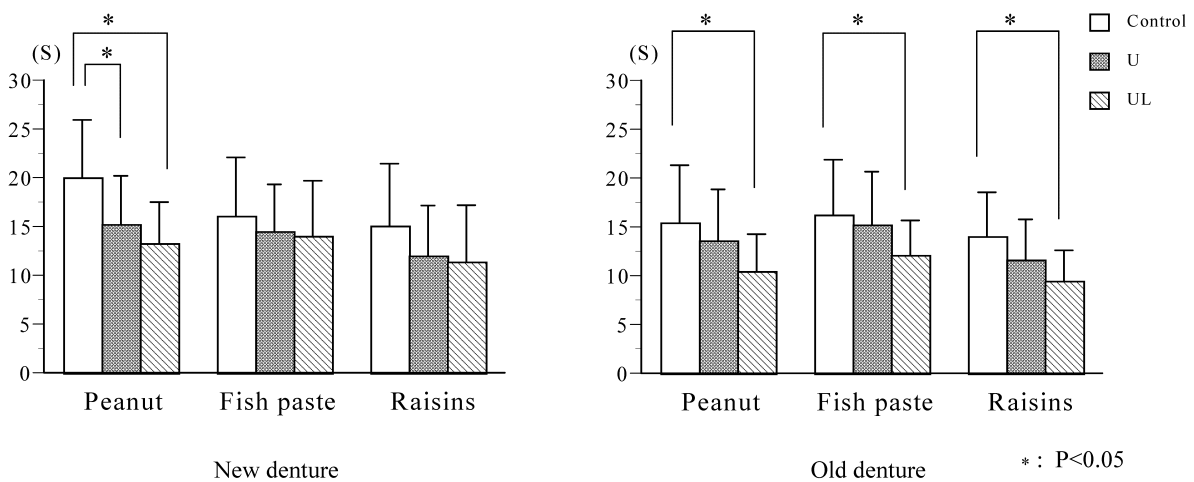


Fig. 6. The average values and their standard deviations of the chewing time during mastication.

Control: no adhesive, U: adhesive applied to the upper denture, UL: adhesive applied to the upper and lower dentures.

* : $P < 0.05$

differences between the Control and UL in chewing each food.

Discussion

Reduction in denture movement due to applying denture adhesive has been documented in certain literature^{17-21,23}. Various techniques have been reported for measuring denture movement, e.g. the cineradiographic technique^{17,18}, mandibular kinesiography

(MKG)¹⁹⁻²² and the magnetometer tracking system²³. It is difficult to analyze multiple moving targets simultaneously using these systems. However, the 3-D optical motion capture system can measure multiple targets in real time, and we were able to simultaneously analyze denture movement as a rigid movement with 6 degrees of freedom and jaw movement.

As far as denture movement is concerned, some authors^{20,23} adopted 10 chewing strokes for the assessment. However, amplitudes of denture movement and rotational denture movement were fairly sta-

ble during the middle and late stage. To exclude the influence of the size of each test food at the early stage, we regarded middle 5 chewing strokes as suitable for the assessment.

Using this system, our study similarly indicates that denture adhesive reduces denture movement in new and old dentures. Furthermore, this study analyzes rotational denture movement because it seems to be more strongly related to demonstrating the entire denture movement.

Denture adhesive reduces rotational denture movement in both dentures, also. In addition, there is no statistically significant difference in improvement in the denture movement between the new and old dentures, for any of the foods.

The movement of the new dentures was qualitatively similar on the working (right) and non-working (left) sides while each test food was chewed on the habitual side (all subjects: right side), regardless of applying the denture adhesive (Tab. 1). However, the denture movement was not equivalent between the working and non-working sides without denture adhesive for the old dentures. Applying denture adhesive to the old dentures contributed to reducing denture movement and preventing a drop in the denture base on the non-working side (Tabs. 2 and 4). This indicates that denture adhesive improves retention and stability, while reducing denture movement and preventing staggering of the denture base. However, the old dentures had greater movement than the new dentures before applying the denture adhesive (Tabs. 3 and 5). In this study, the old dentures were able to regain retention and stability owing to denture adhesive to the same extent as new dentures without adhesive ("Control") (Tab. 6). It seems reasonable and convenient to use denture adhesive to regain denture retention and stability. However, old dentures may need relining or need to be replaced. There are various insoluble clinical problems with old dentures if only denture adhesive is used. It may conceal the risk of continued wear of poorly fitting dentures that require treatment. Although denture adhesive may reduce denture movement in both dentures, it may be more beneficial to use denture adhesive for new dentures to satisfy further requirements.

According to Rendell et al.²⁴ the application of denture adhesive tends to make chewing rate increased. That is, denture adhesive tends to make cycle time reduced. They suggest that the use of the denture adhesive helped complete denture wearers achieve a mean chewing rate comparable with the subjects with

natural teeth. In our study, however, denture adhesive produced no change in cycle time, in other words, no change in chewing rate. Probably, it may depend on the amount of the test food. Our subjects had smaller amount of test food than that of the cases reported by Rendell et al.²⁴.

Chewing time was reduced in both dentures by applying denture adhesive. In a previous study²⁵, the use of denture adhesive improved masticatory performance for complete denture wearers who have poor denture-bearing tissue. Reduction of chewing time might occur as a sequence to improve the food pulverization. This fact suggests that the number of chewing decreased.

For chewing time, applying denture adhesive to the upper and lower dentures was more effective than applying it only to the upper denture (Fig. 6). Mirza et al.¹² have reported that denture adhesive improves retention of the lower denture. Grasso et al.²³ have reported that mandibular denture movement under both adhesive and non-adhesive conditions are significantly greater than maxillary denture movement, and that the denture adhesive significantly reduces movement of the maxillary and mandibular denture. This suggests that applying denture adhesive to the lower denture has a similar effect to applying adhesive to the upper denture. It is also possible that improvement in retention and stability of dentures contributes to reducing chewing time.

Conclusion

This study analyzes the effects of denture adhesive on the stability of complete dentures and the masticatory function using a 3-D optical motion capture system.

1. While chewing, applying denture adhesive tended to reduce maxillary 3-D denture movement in new and old dentures. But there was no statistically significant difference in improvement in the 3-D denture movement between the new and old dentures, for any of the foods.

2. As far as rotational denture movement is concerned, same tendency was obtained. Denture adhesive tended to reduce rotational denture movement. There was no statistical significant improvement between the new and old dentures, for any of the food.

3. For the cycle time, there was no statistically significant difference among the conditions of applying denture adhesive.

4. The chewing time is reduced for both dentures by

applying denture adhesive.

The results suggest that denture adhesive contributes to reducing denture movement and therefore to improving chewing function.

References

1. Adisman IK. The use of denture adhesives as an aid to denture treatment. *J Prosthet Dent* 1989;62:711-715.
2. Shay K. Denture adhesives: Choosing the right powders and pastes. *J Am Dent Assoc* 1991;122:70-76.
3. Grasso JE. Denture adhesives: Changing attitudes. *J Am Dent Assoc* 1996;127:90-96.
4. Slaughter A, Katz RV, Grasso JE. Professional attitudes toward denture adhesives: A Delphi Technique survey of academic prosthodontists. *J Prosthet Dent* 1999;82:80-89.
5. Boone M. Analysis of soluble and insoluble denture adhesive and their relationship to tissue irritation and bone resorption. *Compend Cont Educ Dent* 1984;4(Supplement):22-25.
6. Tarbet WJ, Grossman E. Observations of denture-supporting tissue during six months of denture adhesive wearing. *J Am Dent Assoc* 1980;101:789-791.
7. Means CR. A report of a user of home reliner materials. *J Prosthet Dent* 1964;14:935-938.
8. Woelfel JB, Kreider JA, Berg TJ. Deformed lower ridge caused by relining of a denture by a patient. *J Am Dent Assoc* 1962;67:763-769.
9. Norman RD, Stewart GP, Maroso DJ, et al. In vitro measurement of vertical denture displacement by denture adhesives. *Dent Mater* 1987;3:342-346.
10. Tarbet WJ, Silverman G, Schmidt NF. Maximum incisal biting force in denture wearers as influenced by adequacy of denture-bearing tissues and the use of an adhesive. *J Dent Res* 1981;60:115-119.
11. Ow RKK, Bearn EM. A method of studying the effect of adhesives on denture retention. *J Prosthet Dent* 1983;50:332-337.
12. Mirza FD, Dikshit JV, Muradia NS. Effectiveness of denture adhesive at different time intervals. *J Indian Dent Assoc* 1983;55:9-13.
13. Kanapka JA. Bite force as a measure of denture adhesive efficacy. *Compend Cont Educ Dent* 1984;4 (Supplement):26-30.
14. Panagiotouni E, Pissiotis A, Kapari D, et al. Retentive ability of various adhesive materials: An in vitro study. *J Prosthet Dent* 1995;73:578-585.
15. Kapur KK. A clinical evaluation of denture adhesives. *J Prosthet Dent* 1967;18:550-558.
16. Miyashita K, Sekita T, Minakuchi S, et al. Denture mobility with six degrees of freedom during function. *J Oral Rehabil* 1998;25:545-552.
17. Karlsson S, Swartz B. Denture adhesives-their effect on the mobility of full upper denture during chewing. *Swed Dent J* 1981;5:207-211.
18. Karlsson S, Swartz B. Effect of a denture adhesive on mandibular denture dislodgment. *Quintessence Int* 1990;21:625-627.
19. Chew CL, Phillips RW, Boone ME, et al. Denture stabilization with adhesives: A kinesiographic study. *Compend Cont Educ Dent* 1984;4 (Supplement):32-38.
20. Chew CL, Boone ME, Swartz ML, et al. Denture adhesives: Their effects on denture retention and stability. *J Dent* 1985;13:152-159.
21. Grasso JE, Rendell J, Gay T. Effect of denture adhesive on the retention and stability of maxillary dentures. *J Prosthet Dent* 1994;72:399-405.
22. Rendell J, Grasso JE, Gay T. Retention and stability of the maxillary denture during function. *J Prosthet Dent* 1995;73:344-347.
23. Grasso JE, Gay T, Rendell J, et al. Effect of denture adhesive on retention of the mandibular and maxillary dentures during function. *J Clin Dent* 2000;11:98-103.
24. Rendell J, Gay T, Grasso JE, et al. The effect of denture adhesive on mandibular movement during chewing. *J Am Dent Assoc* 2000;131:981-986.
25. Fujimori T, Hirano S, Hayakawa I. Effects of a denture adhesive on masticatory functions for complete denture wearers. *J Med Dent Sci* 2002;49:151-156.