

Research Article

The Effect of Viscosity of Oral Moisturizers and Residual Ridge Form on the Retention Force of Maxillary Complete Dentures

Mari Takayama*, Yuji Sato, Noboru Kitagawa, Momoe Nakatsu, Kazuko Yamagaki, Kana Aoyagi, Takuya Kakuda, Kensuke Tsubakida, and Ishihara Masae

Department of Geriatric Dentistry, Showa University, Japan

***Corresponding author**

Mari Takayama, Department of Geriatric Dentistry, Showa University, School of Dentistry, 2-1-1 Kitasenzoku Ota Ward, Tokyo 145-8515, Japan, Tel: 81-3-3787-1151; Fax: 81-3-3787-3971; Email: hana.mari@dent.showa-u.ac.jp

Submitted: 08 November 2016

Accepted: 14 December 2016

Published: 16 December 2016

ISSN: 2333-7133

Copyright

© 2016 Takayama Jr et al.

OPEN ACCESS

Keywords

- Oral moisturizer
- Viscosity
- Complete denture
- Retention force
- Gerodontology

Abstract

Aim: To study the effects of viscosity of oral moisturizers and residual ridge form on the retention force of maxillary complete dentures.

Methods: Thirty-five maxillary edentulous participants were recruited. Three types of oral moisturizers with different viscosities, artificial saliva, and denture adhesive were used. These were applied between the intaglio surface of the denture and basal seat mucosa. The central incisor was loaded 45° upward to the occlusal plane. The force needed to dislodge the denture was measured using a digital force gauge. Dental impressions of the polished surfaces and intaglio surfaces of the maxillary complete dentures were obtained. Then, duplicate dentures were cast using auto polymerizing acrylic resin. The buccolingual molar residual ridge form was assessed using the dental impressions. The duplicate denture was used to measure the positional relationship of the central incisor edge, anterior residual ridge crest, and posterior border of dentures. The effect of residual ridge form on retention force was analyzed.

Results: The gel-type oral moisturizer showed significantly greater retention than the other types ($P < .05$). The retention force and buccolingual molar residual ridge form were not correlated. As the ratio of the distance from the central incisor to the anterior residual ridge crest and the distance from the anterior residual ridge crest to the posterior denture border increased, retention force decreased ($r = -0.352$; $P < .01$).

Conclusion: The results indicate that the retention force of dentures is affected by oral moisturizer viscosity and the relative position of the anterior residual ridge crest.

INTRODUCTION

The proportion of elderly people in Japan (aged ≥ 65) is increasing at a rapid rate and is the highest in the world; the elderly now account for 26.0% of the total population, which is the highest figure on record, and the proportion is predicted to increase further over the next 30 years [1]. Although the total number of patients with complete dentures has remained stable, due to a rise in the number of those with persistent teeth, it is anticipated that the number of intractable cases will rise in tandem with the increasing life-span. A history of systemic disease [2-5], increased xerostomia [5-8], and changes in residual ridge resorption and jaw position [5,9,10], make complete denture retention difficult. Complete denture treatment affects the quality of life of the elderly and their prognosis [2,5,9,11-13]. Accordingly, there is an increasing demand for better quality complete dentures.

It is believed that the increase in the number of intractable cases would result in the increased use of denture adhesive creams for denture retention and stabilization. Denture adhesive creams are designed to increase the retention force of dentures; upon hydration with saliva and water, their viscosity increases, and the viscous adhesive interposes itself between the intaglio surface of the denture and basal seat mucosa [10], increasing the retention force. However, denture adhesive creams are difficult to remove from the oral mucosa [14]. Furthermore, when left in the oral cavity, the adhesive creams become hotbeds of bacteria, posing a significant oral health risk [14,15]. Given the risks associated with denture adhesive use, our previous studies focused on the use of oral moisturizers, which are used in symptomatic xerostomia treatment. The effect of differences in the physical properties of oral moisturizers on retention force

was evaluated using an upper edentulous model (G10 FE – 402 K, Nissin, Tokyo). It was found that highly viscous oral moisturizers increase retention force to the same extent as denture adhesives [16]. There are a number of reports on the influence of denture adhesives on retention force [17-22], however, only one study investigated the effects of oral moisturizers on retention force [20]. Our first null hypothesis was that highly viscous oral moisturizers do not affect retention force in the oral cavity. Therefore, a device to objectively measure the retention forces of maxillary complete dentures was developed, and the optimal site and loading method for measuring denture retention at chair side were identified [23].

In our previous studies, reference values and a diagnostic scale for assessing residual ridge height and shape were established [24]. Residual ridge height and shape were previously used to classify cases based on the Japan Prosthodontic Society's guidelines [25], in which it is suggested that these parameters are closely correlated with the intractability of a disease. However, very few studies have examined the effect of residual ridge height and shape on retention force. Thus, the second null hypothesis was that residual ridge height and shape do not affect denture retention. In the present study, the loading site and residual ridge assessment method that were developed in previous studies were used to examine the effects of viscosity of oral moisturizers and residual ridge form on the retention force of maxillary complete dentures.

MATERIALS AND METHODS

Measuring the retention force of maxillary complete dentures

Participants: The participants were 35 recall patients using maxillary complete dentures that do not require intaglio surface adjustment who visited the Department of Geriatric Dentistry of the Showa University Dental Hospital (14 male and 21 female patients; average age, 81.3 ± 6.7 years). Those with residual dental root, which affects bone absorption, or mucosal abnormalities, which could affect the measurements, were excluded. No participant was allergic to oral moisturizers or denture adhesives. Before participation, the participants received a complete explanation of the purpose of the study and consented to participation. The study was approved by the Medical Ethics Committee of the Showa University School of Dentistry (Approval No. 2013-043).

Mediating fluids: The fluids were applied between the oral mucosa and the intaglio surface of the maxillary complete dentures worn by the participants. From our previous study, five mediating fluids were selected: an artificial saliva, three types of oral moisturizer, and a denture adhesive. The details of each are shown in Table 1, together with the manufacturer and viscosity data, which were based on the results of Yamagaki et al. [16]. Viscosity was measured using a digital rotational viscometer (Brookfield Rotational Viscometer®; Osaka, Japan). The viscosity of two 500-mL samples from each subject was measured at a temperature of 20°C. The average viscosity measure was used.

Measurement of the retention force: The retention force measuring device used the same digital force gauge (Digital Force gauge RX Series®; AIKOH ENGINEERING, Tokyo, Japan) as that used by Yamagaki et al. [16]. The tension jig was fit using a hook-shaped component. The tip of the component was processed so

Table 1: Details of the five mediating fluids.

Materials	Type	Manufacturer	Viscosity (mPa · s)
Saliveht®	Artificial Saliva	Teijin Pharma, Tokyo, Japan	6
Wet Care®	Oral moisturizer(Spray)	Kissei Pharma Ceutical, Nagano, Japan	2
Oral balance Liquid®	Oral moisturizer(Liquid)	T&K, Tokyo, Japan	13,000
Biotene Oral balance Jell®	Oral moisturizer(Gel)	T&K, Tokyo, Japan	490,000
New Poligrip® Sa	Denture adhesive	Glaxo Smith Kline, Tokyo, Japan	Unmeasurable

as not to deviate from the measurement site. An acrylic plate was attached at a 45° angle to prevent damage to the participant's oral mucosa or dentures during dislodgment (Figure 1).

The retention force measuring device was positioned in a way that allowed vertical tension and thereby ensured stable measurement (the occlusal plane was set at 45° relative to the floor). The measurement site was the incisal edge of the central incisors (Figure 2). Kakuda et al., suggested that the measurement site is optimal site for measurement of maxillary complete denture retention force without the special jig and cracking [23]. Assuming denture dislodgement, the measurement direction was 45° with respect to the occlusal plane. The force required to dislodge the denture was considered as the retention force.

Retention force was measured in the following order: First, an initial measurement was conducted without interposing any liquid. Next, retention force was measured with artificial saliva and the three types of oral moisturizers, six times each. The first of these measurements was excluded to adjust for instability due to changes in mucosa viscosity. Finally, the



Figure 1 Photograph of a digital force gauge. The image shows the tension jig that was fitted using a hook-shaped component and the acrylic plate attached at a 45° angle.

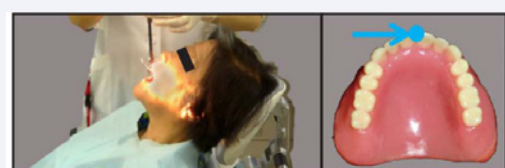


Figure 2 Measurement landscape and measurement position. The participant's occlusal plane was at 45° relative to the floor. Spot indicated by the arrow is the tension position and the incisal edge of the central incisors.

retention force was measured once with the denture adhesive. Because of the difficulty of removing the denture adhesive from the intaglio surface of the denture and basal seat mucosa, only one measurement was conducted with the denture adhesive. The volume of mediating fluid used was the volume that fully covered the intaglio surface of the denture. To fit the denture into the oral cavity, approximately 20 N of force was applied (the same researcher applied the pressure and practiced applying a constant force on models before the experiment) for 10 seconds, after which the measurement was conducted. Traction was exerted at a fixed rate of 0.5 N/s.

Measurement was discontinued when the measured value exceeded 20 N, as preliminary research indicated that this level of pressure can cause pain and impede measurement, or when the participant complained of pain. If the aforementioned impediments to measurement occurred twice, subsequent measurements were discontinued.

Measuring residual ridge form

Dental impression and casting of duplicate dentures:

To analyze the effect of residual ridge form on retention force, duplicate dentures were casted. First, dental impressions of the polished surfaces were obtained using a silicone impression material (Examixfine® putty type and injection type; GC, Tokyo, Japan) and impression tray (Rimrocktray®; DENTSPLY SANKIN, Tochigi, Japan). Second, intaglio surface of the maxillary complete dentures were obtained using these materials. Then, a duplicate denture was casted by pouring a denture impression auto polymerizing acrylic resin (Tray resin®, SHOFU INC., Kyoto, Japan) onto the impressions (Figure 3). Production method was based on the methods of Kakuda et al. [23].

Measuring buccolingual molar residual ridge height and shape: Measurements were conducted using the method developed by Ishibashi et al. [24]. Using a supporting tissue scale, dental impressions were measured for the height and shape of the residual ridge of the retrozygomatic fossa of the right and left first molars (15 mm forward from the front edge of the hamular notch) (Figure 4). The residual ridge height values were divided into three categories: low (< 6 mm), middle (≥ 6 mm and < 10 mm), and high (≥ 10 mm). The residual ridge shape was categorized as follows: flat, V, UV (middle), and U. In cases where the residual ridge height was deemed to be low, the residual ridge shape was considered to be flat. When the width was < 7 mm, it was categorized as V; when the width was ≥ 7 mm and < 9 mm, it was categorized as UV; and when the width was ≥ 9 mm, it was categorized as U (Figure 5). Complete denture treatment is considered to be easier in patients with a “high” residual ridge height, followed by “middle”, and “low”. Regarding the residual

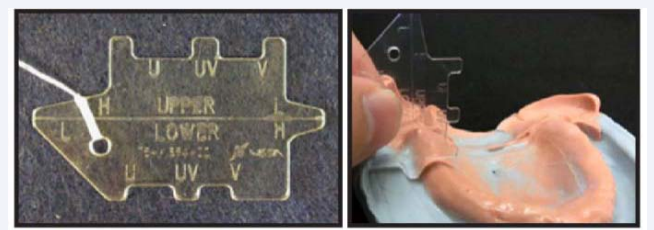


Figure 4 Supporting tissue scale and measurement landscape. The supporting tissue scale is fit into the residual ridge of the retrozygomatic fossa of the right and left first molars.

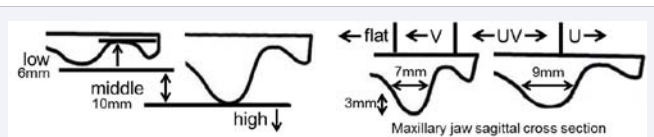


Figure 5 Details of residual ridge height and shape. Classification of the residual ridge height; Low: < 6 mm, middle: ≥ 6 mm and < 10 mm, high ≥ 10 mm. Classification of the residual ridge shape; Flat: In cases where the residual ridge height was deemed to be low, V: < 7 mm, UV: ≥ 7 mm but < 9 mm, U: ≥ 9 mm.

ridge shape, the ease of treatment increases in the order flat, V, UV, U [25]. Hence, the residual ridge height and residual ridge shape were measured on both sides and the side with poorer residual ridge height and shape was selected for comparison. Based on these values, the influence of residual ridge height and residual ridge shape on retention force was analyzed.

Measuring the positional relationship of central incisor edge, anterior residual ridge crest, and posterior border of dentures:

In the measurement of tension force at the median of the left and right central incisor edge, it was clear that a force to dislodge the denture was added around the anterior residual ridge crest. Hence, the positional relationship of the central incisor edge, the anterior residual ridge crest, and the posterior denture border were measured.

Using the duplicate dentures, measurements by two methods were conducted. The first method involved projecting three points of the duplicate dentures—the incisal edge of the central incisor, the anterior residual ridge crest, and the posterior border of the duplicated denture onto an occlusal plane using a surveyor (SURVEYOR KM-I®, GC, Tokyo, Japan). The distances of the three projected points were then measured. The second method involved measuring the distances of the three points using calipers (LABORATORY CALIPERS®, YDM Corporation, Tokyo, Japan) (Figure 6).

The relative position of the anterior residual ridge crest against the distance of the posterior border of the duplicated dentures from the central incisor edge was examined. The influence of each position and the relative positions of the anterior residual ridge crest against the distance of the posterior border of the duplicated dentures from the central incisor edge on retention force was analyzed.

Statistical analysis: For all the measurements, the Shapiro-Wilk test was performed as a test for normality ($P < .05$).



Figure 3 Impressions of the polished surfaces and basal surfaces of the maxillary complete dentures and the duplicate denture. The duplicate denture was made from autopolymerizing acrylic resin.

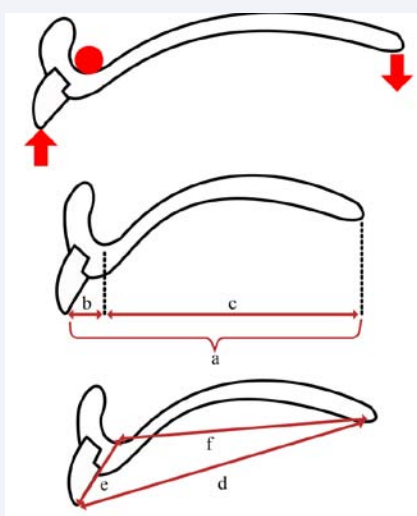


Figure 6 Image showing the effort at the median of the left and right central incisor edge. In this case, the fulcrum is the anterior residual ridge crest and the load is the posterior denture border. The figure on the lower middle the measurement site for the first measurement method. The figure on the lower shows the measurement site for the second measurement method.

Using the Friedman test, an analysis of variance (ANOVA) on the mean values for retention force under each of the four conditions was performed. Then, a multiple comparison using the Bonferroni method was performed ($P < .05$). For the analysis of the height and shape of the molar residual ridge, the Kruskal-Wallis test was performed ($P < .05$). Spearman's rank correlation coefficient was used to analyze the relationship between retention force and the positional relationship of the central incisor edge, the anterior residual ridge crest, and the posterior denture border ($P < .01$). For statistical analysis, SPSS (version 19; SPAW Statistics Base 19®; IBM, Tokyo, Japan) was used.

RESULTS

Retention force under the six conditions

Of the 35 participants, one participant had a measured value that exceeded 20 N, and one participant complained of pain; hence, for these participants, measurement was discontinued. Therefore, the data for the remaining 33 participants were analyzed.

According to our results, retention force values with the gel-type oral moisturizer were the highest compared to the artificial saliva and other oral moisturizers ($P < .05$) (Table 2 and Figure 7). The average retention force without interposing any liquid was 4.4 ± 2.5 N. The average retention force with denture adhesive was 5.3 ± 2.1 N.

Correlation between retention force, and buccolingual molar residual ridge height and residual ridge shape

The residual ridge height was classified as low in 10 participants, as middle in 19, and as high in 4. A significant relationship between the residual ridge height and retention force with mediating artificial saliva was not observed ($P > .05$). Ten subjects had a flat residual ridge shape; 5 had a V shape; 10 had a UV shape; and 8 had a U shape. A significant relationship between the residual ridge shape and retention force with

mediating artificial saliva was not observed ($P > .05$) (Table 3). Significant relationships between the residual ridge height and shape and retention force with oral moisturizers were not observed ($P > .05$).

Correlation between retention force and the positional relationships of the central incisor edge, the anterior residual ridge crest, and the posterior denture border

When the distances were measured by projecting these three points onto the occlusal plane (first measurement method), there were no significant correlation between the distances and retention force with mediating artificial saliva. There were no significant correlation between the "ratio of the distance of the anterior residual ridge crest from the central incisor edge (b) to the distance of the posterior border of the denture from the central incisor edge (a)" and retention force with three types of oral moisturizers. When the distances were measured using calipers (second measurement method), there was a significant negative correlation between the "ratio of the distance of the anterior residual ridge crest from the central incisor edge (e) to the distance of the posterior border of the denture from the central incisor edge (d)" and retention force with mediating artificial saliva (Table 4 and Figure 8). Although, there was a significant negative correlation between the "ratio of the distance of (e) to the distance of (d)" and retention force with gel type of

Table 2: Retention forces under four conditions: multiple comparison test ($n = 33$).

Sample1-Sample2	Test-statistics	Std.-Error	Std. Test-statistics	Sig.	Adjusted. Sig.
Artificial Saliva-Spray	-.576	.461	-1.250	.211	1.000
Artificial Saliva-Liquid	-1.515	.461	-3.290	.001	.015
Artificial Saliva-Gel	-3.333	.461	-7.237	.000	.000
Spray-Liquid	-.939	.461	-2.040	.041	.621
Spray-Gel	-2.758	.461	-5.987	.000	.000
Liquid-Gel	-1.818	.461	-3.948	.000	.001

The liquid-type oral moisturizer yielded significantly greater retention force than artificial saliva ($P < .05$). Retention force values with the gel-type oral moisturizer were the highest ($P < .05$).

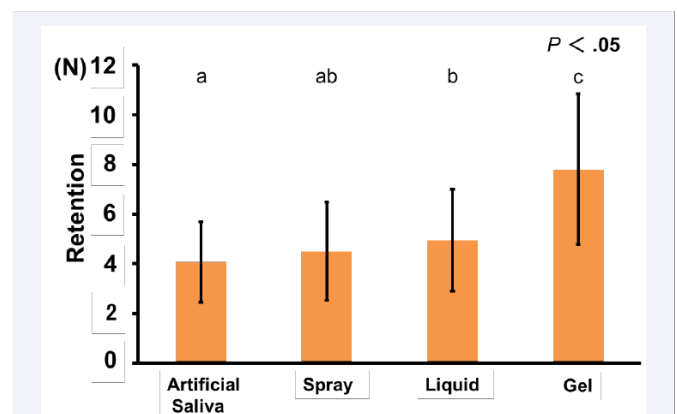


Figure 7 Graph showing the mean value of the retention forces under four conditions. The same letters indicate a non-significant relationship.

Table 3: Relationship between retention force with mediating artificial saliva, and residual ridge height and shape (n = 33).

	Median (SD)						
	Height			Shape			
	Low	middle	high	flat	V	UV	U
Artificial Saliva	3.9 ± 1.4	4.0 ± 1.5	4.7 ± 2.8	3.9 ± 1.5	4.6 ± 2.3	4.2 ± 1.3	3.8 ± 2.0
Comparison	NS			NS			

A significant relationship between the residual ridge height/shape and retention force with mediating artificial saliva was not observed ($P > .05$).
Abbreviations: NS: Not Significant (Kruskal-Wallis, ANOVA)

Table 4: Correlation between retention force with mediating artificial saliva and various distances (n = 33).

		a	b	c	b/a	b/c	d	e	f	e/d		e/f
Artificial Saliva	Correlation Coefficient	0.136	-0.113	0.329	-0.289	-0.181	-0.216	-0.326	0.071	-0.352	*	-0.302
	Sig. (2-tailed)	0.450	0.530	0.062	0.102	0.312	0.228	0.064	0.695	0.045		0.088
	N	33	33	33	33	33	33	33	33	33		33

a= Distance of the central incisor edge to the posterior denture border by the first measuring method.
 b= Distance of the central incisor edge to the anterior residual ridge crest by the first measuring method.
 c= Distance of the anterior residual ridge crest to the posterior denture border by the first measuring method.
 d= Distance of the central incisor edge to the posterior denture border by the second measuring method.
 e= Distance of the central incisor edge to the anterior residual ridge crest by the second measuring method.
 f= Distance of the anterior residual ridge crest to the posterior denture border by the second measuring method.
 *Statistically significant ($P < .01$ 2-tailed)

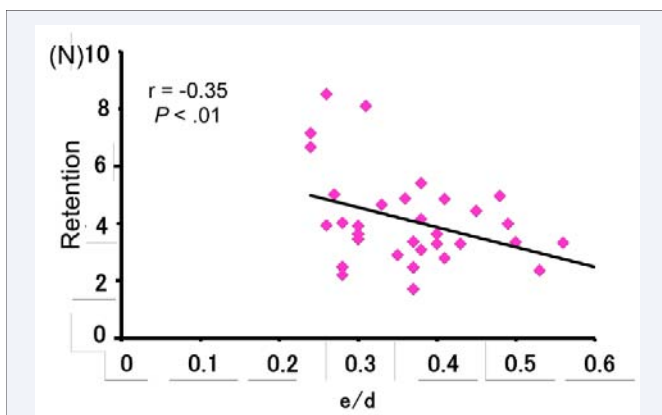


Figure 8 Correlation between retention force mediating artificial saliva and “ratio of distance of the anterior residual ridge crest from the central incisor edge (e) relative to distance of posterior border of the denture from central incisor edge (d)” as per the second measurement method.

oral moisturizer ($r = -0.515$), but not for spray and liquid types of oral moisturizers.

DISCUSSION

The mediating fluids were determined after referring to previous studies. Kawazoe et al. reported that both excessively high and excessively low amounts of saliva interposed between the denture base and the basal seat mucosa weaken retention force, suggesting that the optimal amount of interposing saliva varies from individual to individual [26]. Yamagaki et al., reported that stable retention force readings were obtained when the entire surface of a model was covered with the mediating fluid [16]. Given that there is no definite optimal volume of mediating fluid, the volume that fully covered the basal surface of the denture was chosen.

Five different fluids were selected as mediating fluids: artificial saliva, three types of oral moisturizers of varying viscosities, and a denture adhesive. The reasons for selecting these fluids are as follows. Artificial saliva has largely the same inorganic electrolyte composition as normal saliva. Many studies, such as that by Östlund et al., report that differences in the properties, composition, and amounts of saliva have a considerable effect on retention force [7, 20, 26, 27]. The purpose of this measurement was to check whether measurements could be conducted without hurting the participant and to obtain reference values of retention force. Furthermore, to compare the effect of height and shape of the molar residual ridge and the relative positions of the central incisor edge, the anterior residual ridge crest, and the posterior border of the duplicate denture on retention force, while controlling for saliva condition differences among the participants, artificial saliva with a viscosity similar to human saliva was used as the mediating fluid. Yamagaki et al., reported that the more viscous the oral moisturizer is, the greater the retention force will be on the model [16]. Accordingly, to clarify the relationship between the viscosity of oral moisturizer and the retention force of the maxillary complete dentures worn by the participants, three types of oral moisturizers with varying viscosities were selected. Yamagaki et al., reported that highly viscous oral moisturizers may act as substitutes to denture adhesives. Accordingly, to compare their effect with that of oral moisturizers, the retention force was also measured when denture adhesive was used as the mediating fluid. This study rejected the first null hypothesis that highly viscous oral moisturizers do not affect retention force in the oral cavity. Oral moisturizers with higher viscosity yielded higher retention force values in the maxillary complete dentures worn by the participants. This finding reveals that oral moisturizers have the potential to increase the retention force of dentures. Although the viscosity of the denture adhesive was higher than

that of the oral moisturizers, the retention force obtained with the gel type of oral moisturizer was higher than that obtained with the denture adhesive. The optimal use of oral moisturizers for denture retention has not yet been determined. The time used to pressure-fit the denture (10 s) in this study was based on our previous research. This finding suggests that the time required for denture adhesives to take hold in the oral cavity is longer than the pressure-fitting time used in this study, and that oral moisturizers may be suitable for denture retention, at least in the short-term. Further studies are needed in order to investigate the duration that oral moisturizers can sustain their retentive force, and the feasibility of long-term use.

There is no globally standardized method for assessing the height and shape of the buccolingual molar residual ridge [25,28]. A previous study suggested that bone absorption reduces retention force [10], but the only study that measured the height and shape of the residual ridge based on a measuring method analogous to that used in our study, and compared them to retention force is the study by Kakuda et al. [23]. This study failed to reject the second null hypothesis that residual ridge height and shape do not affect denture retention. In our study, no significant correlation was observed between the height and shape of the residual ridge and retention force. Retention force was measured at the incisal edge of the central incisors. The fulcrum was the anterior residual ridge crest. Hence, the height and shape of the buccolingual molar residual ridge could not have a significant influence on retention force. However, the study had a small number of participants with which to compare the effect of height and shape of the residual ridge on denture retention. Moreover, denture retention may be affected by other factors, such as biological and mechanical factors [9]. Further studies to validate the results of our study are warranted.

A previous study demonstrated that the position of the posterior border of the denture is important to the retention force of maxillary complete dentures [9]. However, only a single report on the effects of the positional relationship of the central incisor edge, the anterior residual ridge crest, and the posterior border of the denture on retention force exists [23]. Therefore, the positional relationship of the central incisor edge, the anterior residual ridge crest, and the posterior border of the denture was measured using two methods. Regarding the difference between the two measuring methods, the first method examined the anteroposterior position of the anterior residual ridge crest to the distance of the posterior border of the denture from central incisor edge (a) (which shows that bone absorption of only the maxillary anterior residual ridge is inward). The second method examined the up-down anteroposterior position of the anterior residual ridge crest to the distance of the posterior border of the denture from the central incisor edge (d) (which shows that bone absorption of the maxillary anterior residual ridge are upward and inward). Accordingly, correlation between retention forces with artificial saliva was only observed in the results from the second measuring method, which describes the bone absorption of the maxillary anterior residual ridge, which takes place in an organism.

Retention force measurement methods that use the incisal edge of the central incisors are not highly dependent on the

position of the posterior border of the denture. Retention force measurement methods that use the incisal edge of the central incisors are highly dependent on the up-down anteroposterior position of the anterior residual ridge crest to the distance of the posterior border of the denture from central incisor edge, as in this study. This result suggests that the retention force of maxillary complete dentures depends on not only the position of the posterior border of the denture, but also on the relative positions of the central incisor edge with respect to the distance of the posterior border of the denture from central incisor edge. Hence, these positions were considered.

In the future, it would be desirable to measure denture retention force in a larger sample to evaluate how retention force is affected by conditions such as the elasticity, thickness of the mucous membrane and residual ridge, the shape of the palate. It would also be desirable to clarify how xerostomia affects denture retention force and to clarify the relationship between an objective assessment of retention force and patients' satisfaction level with respect to each mediating fluid.

An understanding of these factors would enable the provision of better quality maxillary complete dentures, thereby improving the quality of life of edentulous elderly people.

CONCLUSION

The results indicated that the more viscous an oral moisturizer is, the greater the denture retention force will be. In addition, this relationship is affected not only by the molar residual ridge form but also by the relative position of the anterior residual ridge crest.

ACKNOWLEDGEMENTS

The authors would like to thank the staff of the Department of Geriatric Dentistry of Showa University. The authors also thank Dr. Takahashi, Professor in the Department of Special Needs Dentistry Division of Oral Rehabilitation of Showa University, Dr. Nakamura, Professor in the Department of Oral Anatomy, and Dr. Hironaka, Professor in the Department of Special Needs Dentistry Division of Hygiene and Oral Health, for their meticulous critique. The present study was partially supported by the Research Funding for Longevity Sciences (25-7) from the National Center for Geriatrics and Gerontology (NCGG), Japan.

REFERENCES

1. Cabinet Office Annual Report on the Aging Society. 2014.
2. Shimazaki Y, Soh I, Saito T, Yamashita Y, Koga T, Miyazaki H, et al. Influence of dentition status on physical disability, mental impairment, and mortality in institutionalized elderly people. *J Dent Res.* 2001; 80: 340-345.
3. Triantos D. Intra-oral findings and general health conditions among institutionalized and non-institutionalized elderly in Greece. *J. Oral Pathol Med.* 2005; 34: 577-582.
4. Panek H, Krawczykowska H, Dobosz A, Napadlek P, Panek BA, Sosna-Gramza M. Follow-up visits as a measure of adaptation process to removable prostheses. *Gerodontology.* 2006; 23: 87-92.
5. Polzer I, Schimmel M, Muller F, Biffar R. Edentulism as part of the general health problems of elderly adults. *Int Dent J.* 2010; 60: 143-155.

6. Narhi TO. Prevalence of subjective feelings of dry mouth in the elderly. *J Dent Res.* 1994; 73: 20-25.
7. Navazesh M, Brightman VJ, Pogoda JM. Relationship of medical status, medications, and salivary flow rates in adults of different ages. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1996; 81: 172-176.
8. Ikebe K, Morii K, Kashiwagi J, Nokubi T, Ettinger RL. Impact of dry mouth on oral symptoms and function in removable denture wearers in Japan. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2005; 99: 704-710.
9. Jacobson TE, Krol AJ. A contemporary review of the factors involved in complete denture retention, stability, and support. Part I: Retention. *J Prosthet Dent.* 1983; 49: 5-15.
10. de Oliveira Junior NM, Rodriguez LS, Mendoza Marin DO, Paleari AG, Pero AC, Compagnoni MA. Masticatory performance of complete denture wearers after using two adhesives: a crossover randomized clinical trial. *J Prosthet Dent.* 2014; 5: 1182-1187.
11. Fukai K, Takiguchi T, Ando Y, Aoyama H, Miyakawa Y, Ito G, et al. Mortality rates of community-residing adults with and without dentures. *Geriatr Gerontol Int.* 2008; 8: 152-159.
12. Regis RR, Cunha TR, Della Vecchia MP, Ribeiro AB, Silva-Lovato CH, de Souza RF. A randomised trial of a simplified method for complete denture fabrication: patient perception and quality. *J Oral Rehabil.* 2013; 40: 535-545.
13. Polzer I, Schwahn C, Volzke H, Mundt T, Biffar R. The association of tooth loss with all-cause and circulatory mortality. Is there a benefit of replaced teeth? A systematic review and meta-analysis. *Clin Oral Investig.* 2012; 16: 333-351.
14. Harada-Hada K, Hong G, Abekura H, Murata H. Evaluation of the efficiency of denture cleaners for removing denture adhesives. *Gerodontology.* 2016; 33: 453-460.
15. Chen F, Mao T, Cheng X. pH and effects on *Streptococcus mutans* growth of denture adhesives: an *in vitro* study. *Gerodontology.* 2014; 31: 95-100.
16. Yamagaki K, Kitagawa N, Sato Y, Okane M, Mashimo J. The relation between the physical properties of oral moisturizer and denture retention force. *Jpn. J Gerodont.* 2011; 26: 402-411.
17. Ghani F, Picton DC. Some clinical investigations on retention forces of maxillary complete dentures with the use of denture fixatives. *J Oral Rehab.* 1994; 21: 631-640.
18. 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.
19. Kulak Y, Ozcan M, Arikan A. Subjective assessment by patients of the efficiency of two denture adhesive pastes. *J Prosthodont.* 2005; 14: 248-252.
20. Sipahi C, Beyzadeoglu M, Demirtas S, Ozen J. Effect of different mucosal and acrylic resin surface treatments in a denture retention model for patients with radiotherapy-induced xerostomia. *Int J Prosthodont.* 2007; 20: 405-408.
21. Kumar MS, Thombare RU. A comparative analysis of the effect of various denture adhesives available in market on the retentive ability of the maxillary denture: an *in vivo* study. *J Indian Prosthodont Soc.* 2011; 11: 82-88.
22. Munoz CA, Gendreau L, Shanga G, Magnuszewski T, Fernandez P, Durocher J. A clinical study to evaluate denture adhesive use in well-fitting dentures. *J Prosthodont.* 2012; 21: 123-129.
23. Kakuda T, Sato Y, Kitagawa N, Nakatsu M, Aoyagi K, Takayama M, et al. Examination of optimal sites and loading methods for measuring maxillary complete denture retention. *Jpn. J Gerodont.* 2015; 30: 25-36.
24. Ishibashi S, Sato Y, Kitagawa N, Hara S, Hosono Y, Ishihara H. A study on the clinical utility of a scale for examination in residual ridge. *Ann Jpn Prosthodont Soc.* 2009; 1: 157-165.
25. Ichikawa T, Sato H, Kuboki T, Sato Y, Hideshima M, Tomotake Y, et al. Classification system for the completely dentate, partial and complete edentulism. *Dent Jpn.* 2006; 42: 209.
26. Kawazoe Y, Hamada T, Yamada S. [Studies on the retention of dentures. Part 4. Changes of intervening salivary volume during tapping movement]. *J Jpn Prosthodont Soc.* 1976; 20: 148-152.
27. Östlund SG. Saliva and denture retention. *J Prosthet Dent.* 1960; 10: 658-663.
28. McGarry TJ, Nimmo A, James FS, Ahlstrom RH, Smith CR, Koumjian JH. Classification system for complete edentulism. *J Prosthodont.* 1999; 8: 27-39.

Cite this article

Takayama M, Sato Y, Kitagawa N, Nakatsu M, Yamagaki K, et al. (2016) The Effect of Viscosity of Oral Moisturizers and Residual Ridge Form on the Retention Force of Maxillary Complete Dentures. *JSM Dent* 4(5): 1077.