Prospective Clinical Trial Comparing Lingualized Occlusion to Bilateral Balanced Occlusion in Complete Dentures: A Pilot Study

Suguru Kimoto, DDS, PhD[a]/Atsuko Gunji, BS[b]/Aiko Yamakawa, DDS[b]/Hiroyuki Ajiro, DDS[b]/Kyoko Kanno, DDS[c]/Mayako Shinomiya, DDS[c]/Yasuhiko Kawai, DDS, PhD[a]/Misao Kawara, DDS, PhD[d]/Kihei Kobayashi, DDS, PhD[e]

Purpose: The aim of this prospective comparative trial was to evaluate whether patients treated with complete dentures with lingualized occlusion (LO) exhibited more positive results than patients treated with complete dentures with bilaterally balanced occlusion (BBO). ***Materials and Methods:*** Twenty-eight completely edentulous patients, ranging in age from 60 to 82 years (mean age 70.9), consented in writing to be participants in this trial. The first 14 patients enrolled in the study protocol were treated with complete dentures with LO, and the next 14 patients were treated with complete dentures with BBO. Baseline characteristics were measured prior to the trial. Main outcome variables involved subjective outcomes of general satisfaction, ability to masticate, and stability and retention of the prostheses; these were quantified with a 100-mm visual analog scale. Objective outcomes were masticatory performance and the number of adjustments. Statistical assessments of the 2 groups were compared using multiple linear regression analysis. The baseline characteristics were analyzed by Student *t* test and chi-square test. ***Results:*** There were no significant differences between the groups at baseline. The height of the alveolar ridge exhibited significant correlations with masticatory performance ($P = .02$). The occlusal scheme exhibited a significant correlation with only the patient's retention satisfaction rating ($P = .03$). ***Conclusion:*** Despite limitations of this study attributed to the small sample size and lack of randomization, this pilot study found that edentulous patients fitted with complete dentures with LO experienced and expressed greater satisfaction with their denture retention. In addition, it was observed that a higher alveolar ridge resulted in greater masticatory performance.
Int J Prosthodont 2006;19:103–109.

Many types of occlusal forms and posterior tooth arrangements have been applied to the construction of complete denture prostheses. Ever since Payne advocated the concept of lingualized occlusion (LO), many in vitro[1–3] and in vivo[4,5] studies have demonstrated that patients with complete dentures arranged with LO may experience better chewing efficacy, stability, retention, esthetics, and comfort.

Arbree et al surveyed the techniques of complete denture prosthodontics in North American dental schools and reported that 11% used LO.[6] This 11% LO adoption rate at dental schools implies that the evidence related to the effectiveness of LO for the complete denture wearers, derived from previous reports, has not yet been decisive. The low prevalence rate of LO is assumed to be a result of a lack of conclusive comparative studies.

Because of the lack of conclusive evidence that recommends one approach for posterior denture occlusion over another, even educators engaged in the instruction of complete denture education at dental schools could not indicate to their undergraduate and postgraduate students which type of occlusal scheme

[a]*Assistant Professor, Department of Gnatho-Oral Prosthetic Rehabilitation, Nihon University School of Dentistry at Matsudo, Japan.*
[b]*Assistant, Department of Gnatho-Oral Prosthetic Rehabilitation, Nihon University School of Dentistry at Matsudo, Japan.*
[c]*Student, Nihon University Graduate School of Dentistry at Matsudo, Japan.*
[d]*Professor, Department of Clinical Oral Physiology, Nihon University School of Dentistry at Matsudo, Japan.*
[e]*Professor, Department of Gnatho-Oral Prosthetic Rehabilitation, Nihon University School of Dentistry at Matsudo, Japan.*

Correspondence to: *Dr Suguru Kimoto, Department of Complete Denture Prosthodontics, Nihon University School of Dentistry at Matsudo, 2-870-1 Sakaecho-nishi, Chiba 271-8587, Japan. Fax: +81-47-360-9376. E-mail: kimoto.suguru@nihon-u.ac.jp*

is most suitable for the completely edentulous patient. As a consequence, the selection of an occlusal scheme for complete dentures, in a variety of clinical settings, is attributed primarily to the practitioner's personal preference and experience.

Given this background, it was considered important to determine whether advantages to treating with LO exist by performing a prospective clinical trial comparing patients treated with LO complete dentures to those treated with complete dentures with bilaterally balanced occlusion (BBO). The purpose of this study was to evaluate whether wearers of complete dentures with LO exhibited more positive results in subjective and objective outcomes than wearers of complete dentures with BBO.

Materials and Methods

Study Population

Twenty-eight edentulous patients (13 men and 15 women) aged 60 to 82 years (mean age 70.9) of Nihon University School of Dentistry at Matsudo Affiliated Hospital, Chiba, Japan, all of whom had volunteered to receive new complete dentures, were enrolled as subjects in this trial. Those with a Class II or III jaw relationship, systemic or neurologic disease, and a lack of understanding of written or spoken Japanese were excluded from participation. The study's protocols and procedures were reviewed and approved by the Ethics Committee at Nihon University School of Dentistry at Matsudo. Prior to the start of the trial, a verbal explanation about the trial was provided, and written informed consent was obtained.

Study Design

This prospective comparative trial was conducted between April 2003 and April 2004. Fourteen patients in each group received either a complete denture with BBO or with LO. After the patients were screened and determined to be suitable candidates for inclusion in this investigation, the first consecutive 14 patients were assigned to the BBO group and the next consecutive 14 volunteers were assigned to the LO group.

A double blinding of intervention was not feasible, since it was quite apparent to the clinicians which artificial teeth were being used; in addition, all of the patients could immediately sense, upon delivery, which type of artificial teeth were being used.

Treatment Protocol

A preliminary impression was made using stock edentulous trays (Dentcraft StO-K Tray, Yoshida) and irreversible hydrocolloid impression materials (Algiace Z, Dentsply-Sankin). Border molding was done using custom trays made of self-curing acrylic resin (Ostron II, GC) and stick modeling compound (Peri Compound, GC), followed by a wash impression with silicone impression materials (Tosicon, Dentsply-Sankin). A jaw relation record was recorded by using wax occlusal rims and zinc oxide bite registration paste (Superbite Paste, Harry J. Bosworth). After verifying the vertical dimensions of the occlusion and centric relation records, the esthetics of the full-contour wax trial denture tooth arrangement was done. Next, the patient's feedback and acceptance of the complete dentures were processed and inserted. Postinsertion follow-up appointments to adjust the dentures were scheduled as needed. When deemed necessary, remounts were done for occlusal equilibration during the adjustment period. Seven clinicians participated in this trial, with each clinician treating 2 LO and 2 BBO patients.

Laboratory Protocol

The complete denture artificial teeth were arranged by 1 of 2 types of occlusion concepts, either LO or BBO.

The complete dentures with LO were arranged as follows: the functional maxillary lingual cusps of the posterior teeth were set in the central groove of the mandibular posterior teeth in lateral and protrusive excursions. The maxillary buccal cusps were elevated and had no contact with the mandibular buccal cusps. During the lateral movement, contact only occurred on the working side between the lingual cusps of the maxillary and mandibular posterior teeth; on the balancing side there was contact between the lingual cusps of the maxillary denture and the lingual inner curve of the buccal cusps of the mandibular denture. Protrusive balanced contacts occurred between the maxillary lingual cusps and the mandibular posteriors. The 20-degree semianatomic commercial artificial tooth (Lingualized Posterior Teeth, GC) was used for the LO group's teeth arrangement.

The complete dentures with BBO were arranged as follows: the functional maxillary lingual cusps of posterior teeth were set in the central groove of the mandibular tooth, and the maxillary buccal cusps were kept in contact with the mandibular buccal cusps. The buccal cusps and the lingual cusps were in articulation and functional in the bilateral and protrusive excursions. The 20-degree semianatomic commercial artificial tooth (Endura, Shofu) was utilized for the BBO group's tooth arrangement.

Table 1 Characteristics of the Trial's 28 Patients

	LO	BBO	*P* value
Mean age (y)	70.6 (9.3)	71.4 (6.9)	.81
Gender (m/f)	6/8	7/7	.71
Edentulous period (y)	15.6 (11.9)	12.4 (8.2)	.41
Age of existing denture (y)	4.8 (5.8)	4.1 (3.9)	.69
No. of previous dentures	3.4 (2.6)	3.2 (3.4)	.86
Height of alveolar ridge (mm)	18.6 (5.6)	19.8 (5.7)	.55

LO = lingualized occlusion; BBO = bilaterally balanced occlusion.
The difference in the mean between the LO and BBO groups were analyzed by *t* test. The proportion of gender was analyzed by ch-square test. There were no significant differences in the baseline characteristics between the LO and BBO groups ($P > .05$).

A semiadjustable articulator (Hanau H2, Teledyne Waterpik) was used for all cases treated in this clinical trial. The dentures were processed with conventional heat-activated acrylic resin denture base (Urban, Shofu) per the manufacturer's instructions. The curing cycle for the prostheses was 90 minutes at 70°C, followed by 30 minutes at 100°C.

Baseline Characteristics

Baseline characteristics of age, gender, edentulous period, age of existing denture, number of previous dentures, and height of the alveolar ridge[7] were collected by an assessor (Table 1).

Main Outcome Variables

The number of postinsertion adjustments was documented until the dentures were judged to be satisfactorily complete based on the patient's feedback of being free of any tissue irritation, as well as a prosthodontist's judgment of observing no clinically observable mucosal ulceration of the denture-bearing area mucosa.

Subjective ratings for the patient's general satisfaction, ability to masticate, stability, and retention of the fabricated complete denture were gathered using a 100-mm visual analog scale (VAS).[8] Masticatory performance was measured by the sieving method of having patients chew 3 g of peanuts 20 times.[9] Both the VAS and masticatory performances were measured 2 months after the postinsertion follow-up. The denture adjustments were judged as satisfactorily complete based on the same previously discussed judgment criteria.

Statistical Analysis

The Student *t* test and chi-square test were used to analyze the baseline characteristics. A multiple linear regression analysis was used to analyze the effects of occlusal scheme and baseline characteristics on the outcome variables. The 4 subjective outcome variables were: general satisfaction, ability to masticate, retention, and stability. The 2 objective outcome variables were masticatory performance and the number of postinsertion adjustments.

A *P* value below .05 was considered statistically significant. All of the analyses were carried out using the Dr SPSS II program for Windows (Dr SPSS II, SPSS Japan).

Results

Table 1 shows the baseline characteristics for the LO and BBO groups. There were no significant differences between groups with regard to mean age, gender, edentulous period, age of existing dentures, number of previous dentures, and height of alveolar ridge. Multiple linear regression analysis indicated that the height of the alveolar ridge exhibited significant correlation with masticatory performance (Table 2; $P = .02$).

The subjective ratings based on the patient's feedback on the VAS for general satisfaction, ability to masticate, stability, and retention of the dentures were 90 ± 8, 94 ± 7, 95 ± 6, and 96 ± 5 for the LO group, and 90 ± 14, 91 ± 13, 89 ± 17, and 81 ± 23 for the BBO group, respectively. Both groups of patients expressed a high degree of satisfaction with their new dentures. Table 2 shows the means and 95% confidence intervals, as well as the *P* values for the estimated partial regression coefficient for the subjective outcomes from

Table 2 Means, 95% Confidence Intervals, and *P* Values for the Estimated Partial Regression Coefficient for the Subjective Outcomes

Outcome Variable	Explanatory Variable	Mean	CI	*P* value
General satifaction (Are you satisfied with denture?)	Occlusal scheme (LO/BBO†)	0.80	−9.1 to 10.7	.87
	Age (y)	0.02	−0.7 to 0.8	.94
	Gender (m/f†)	−8.10	−18.3 to 2.1	.11
	Edentulous period (y)	−0.20	−0.7 to 0.4	.56
	Age of existing dentures (y)	0.60	−0.6 to 1.9	.27
	No. of previous dentures	−0.10	−1.9 to 1.7	.09
	Height of alveolar ridge (mm)	−0.10	−1.2 to 0.9	.79
Satisfaction related to ability to masticate (Can you chew well with denture?	Occlusal scheme (LO/BBO†)	4.30	−4.8 to 13.4	.34
	Age (y)	0.40	−2.8 to 1.1	.23
	Gender (m/f†)	4.40	−11.6 to 7.1	.62
	Edentulous period (y)	−0.10	−0.6 to 0.4	.71
	Age of existing dentures (y)	0.60	−0.5 to 1.7	.29
	No. of previous dentures	0.30	−1.4 to 1.9	.72
	Height of alveolar ridge (mm)	0.40	−0.6 to 1.4	.40
Satisfaction related to stability (Is your denture stable?)	Occlusal scheme (LO/BBO†)	6.70	−4.8 to 18.2	.24
	Age (y)	0.01	−0.9 to 0.9	.98
	Gender (m/f†)	−5.10	−16.9 to 6.8	.38
	Edentulous period (y)	−0.20	−0.9 to 0.4	.48
	Age of existing dentures (y)	0.80	−0.6 to 2.2	.24
	No. of previous dentures	0.10	−2.2 to 2.2	.96
	Height of alveolar ridge (mm)	0.02	−1.2 to 1.3	.96
Satisfaction related to retention (Is your denture retentive?)	Occlusal scheme (LO/BBO†)	16.0	1.3 to 30.8	.03*
	Age (y)	0.40	−0.6 to 1.5	.44
	Gender (m/f)	4.40	−10.8 to 19.6	.55
	Edentulous period (y)	−0.40	−1.3 to 0.4	.34
	Age of existing dentures (y)	0.10	−1.7 to 1.9	.89
	No. of previous dentures	1.10	−1.6 to 3.8	.40
	Height of alveolar ridge (mm)	0.10	−1.5 to 1.7	.90

*The occlusal scheme exhibited a significant correlation with patient satisfaction rating of retention, with signficant increase of 16 mm on VAS for the LO dentures.
†Reference category for the multiple linear regression analysis.

the multiple linear regression analysis. The occlusal scheme exhibited a significant correlation with retention, with a significant increase of 16 mm on VAS for the LO dentures ($P = .03$). The occlusal scheme, however, did not exhibit any significant effects on the patients' general satisfaction, ability to masticate, and stability ($P = .87$, .34, and .24).

Table 3 shows the means, 95% confidence intervals, and *P* values for the estimated partial regression coefficient for the objective outcomes from the multiple linear regression analysis. The masticatory performance was 44.3 ± 15.1 for the LO group and 47.4 ± 15.3 for the BBO group. The occlusal scheme did not exhibit any significant correlation with the masticatory performance ($P = .57$). The mean numbers of postinsertion adjustments were 5.6 ± 1.8 for the LO group and 4.8 ± 1.8 for the BBO group. The occlusal scheme did not exhibit any significant correlation with the number of postinsertion adjustments ($P = .36$).

Discussion

The present study produced evidence in which edentulous patients fitted with complete dentures having a lingualized posterior occlusal scheme expressed greater satisfaction with their denture retention in comparison to patients with complete dentures fabricated with BBO. Though not to the same degree as with the wearers of complete denture with LO, the wearers of complete denture with BBO also expressed satisfaction with their denture retention. From a historical perspective, the LO concept evolved from the BBO concept. Therefore, the LO, in addition to the fundamental advantages derived from BBO, may also exhibit LO-derived advantages resulting from the elimination of the buccal contact of posterior artificial teeth. It was assumed that because of these additional improvements, the LO complete denture wearers would exhibit greater retention satisfaction when compared to the BBO wearers. Increases in their satisfaction level could be attributed to the lingualized occlusal force, which is commonly believed to be a LO mechanical property.

Table 3 Means, 95% Confidence Intervals, and *P* Values for the Estimated Partial Regression Coefficient for the Objective Outcomes

Outcome Variable	Explanatory *t* Variable	Mean	CI	*P* value
Masticatory performance	Occlusal scheme (LO/BBO†)	−0.30	−14.1 to 7.9	.57
	Age (y)	−0.30	−1.1 to 0.5	.46
	Gender (m/f†)	−2.40	−13.8 to 8.9	.67
	Edentulous period (y)	0.20	−0.4 to 0.8	.43
	Age of existing dentures (y)	1.10	−0.3 to 2.4	.11
	No. of previous dentures	0.80	−1.2 to 2.9	.40
	Height of alveolar ridge (mm)	1.50	0.3 to 2.7	.02*
No. of adjustments	Occlusal scheme (LO/BBO†)	0.70	−0.8 to 2.1	.36
	Age (y)	−0.01	−0.1 to 0.1	.83
	Gender (m/f)	0.80	−0.7 to 2.3	.28
	Edentulous period (y)	0.02	−0.1 to 0.1	.48
	Age of existing dentures (y)	−0.20	−0.3 to 0.1	.07
	No. of previous dentures	−0.10	−0.4 to 0.1	.96
	Height of alveolar ridge (mm)	−0.10	−0.3 to 0.1	.22

*A 1-mm increase in the height of the alveolar ridge reflected a significant increase of 0.7% in the masticatory performance value for the edentulous patients.
†Reference category for the multiple linear regression analysis.

With regard to the patients' stability satisfaction ratings, there were no observable differences between the LO and BBO groups. When Payne, in 1941, introduced the concept of LO to dentistry as a modified setup, it was reported that by simply shifting the direction of force from buccal to lingual, this posterior occlusal scheme provided greater stability to the mandibular denture without changing the position of the tooth on the ridge.[10] However, in our study we did not observe any evidence of superior satisfaction related to stability by the LO group when compared to the BBO group. The stability and retention of the complete dentures resulted from a mechanism of moving the occlusal force toward the inner side of the alveolar ridges.[4] This prevented denture base dislocation during mastication. Researchers have been interpreting this nondislocation condition of the denture as implying that the dentures have stability. However, patients may perceive that this same condition pertains to dentures having retention. Consequently, questions and descriptions related to retention in the questionnaire would deeply resonate with the patient's perception, and those related to stability would not. In this study, therefore, the patients were encouraged to respond only to questions related to retention.

There were no differences in the patients' general satisfaction ratings between the LO and BBO groups. There have been many reports that the professionally assessed quality of complete dentures does not agree with the patient's subjective judgments.[11–13] In addition, Awad and Feine[14] discussed that patients' perceptions of their prostheses could not be measured based merely on the patients' satisfaction with their prostheses. Our study results agree with these previous reports. It was thought that patient satisfaction with their dentures could not be based solely from questions related to their satisfaction with the denture's functions.

The complete dentures arranged with LO did not significantly affect masticatory performance. Ono and Hatake[15] investigated differences in the masticatory performance of edentulous patients wearing complete dentures arranged with LO and those wearing dentures arranged with BBO. It was reported that the masticatory performance of the patients with LO and those with BBO was 44.5% and 46.8%, respectively. Similarly, Gomibuchi et al[16] reported that the masticatory performance of patients with LO and BBO were 50.3% and 52.9%, respectively. In our study, masticatory performance with LO and BBO was 44.2% and 47.4%, respectively. All of these studies did not exhibit any significant differences between LO and BBO. Furthermore, there were no significant differences between the LO and BBO groups in the patients' satisfaction ratings of their ability to masticate. While considering all of the pertinent factors, it is appropriate to note that there were no significant differences in masticatory performance between the LO and BBO groups. Clough et al[5] reported that the preference of the complete denture with LO followed patient perceptions of superior masticatory ability in LO when compared to complete dentures with monoplane occlusion, which was used as a control. In our study, however, the complete dentures arranged with BBO were used as a control. It is assumed that any differences in the results between our study and Cough's study can be attributed to differences in the control.

Superior condition of the mandibular alveolar ridge was shown to result in a higher score for masticatory performance. This result agreed with the report of Kimoto et al documenting significantly poorer masticatory performance of complete denture wearers in a low-bone-height group, versus middle- and high-bone-height groups.[17] However, the condition of the mandibular alveolar ridge did not exhibit any statistically significant correlation with masticatory satisfaction. This disparity between the objective and subjective results was quite interesting. It has been suggested that even though the patients' alveolar ridges were poor, the patients were still able to satisfy their daily diet intake under regulated conditions. Garrett et al[18] demonstrated that denture wearers perceive their chewing ability in terms of chewing comfort rather than an ability to comminute food, which is considered an objective measure of chewing performance. This report explained the disparity between the objective and subjective outcomes observed in the present study. Although clinicians are inclined to believe that one of the major factors affecting masticatory satisfaction is the condition of the alveolar ridge, in fact, satisfaction in mastication should not be quantified by the condition of the alveolar ridge.

The number of postinsertion adjustments for the LO group was hypothesized to be fewer than that for the BBO group. This premise was based on the belief that the LO group would experience less denture dislocation, since the LO patients' retention satisfaction ratings were higher than those for the BBO group. However, there were no observable differences in the number of postinsertion adjustments between the LO and BBO groups. It would be quite reasonable to assume that a well-retained denture would reduce or eliminate patient discomfort, such as pain and dysfunction during mastication with the dentures associated with postinsertion dislocation of the dentures. However, the reasons for any increases in the number of postinsertion adjustments should not be considered solely a result of poor denture retention, since other factors affect the number of postinsertion adjustments, including mucosal condition, jaw relation, tooth arrangement, and psychologic factors. Furthermore, even though the complete denture arranged with BBO exhibited less retention satisfaction in comparison to the LO, denture function during mastication was assumed to involve sufficient retention of the denture base to resist any dislodging force that would result in harmful affects to the underlying soft tissue mucosa. Perhaps this is one reason why no differences in the number of postinsertion adjustments were observed between the LO and BBO groups.

It should be noted that the present trial was undertaken as pilot study, and from a clinical and statistical perspective the results are limited and lack power because of the small sample size and lack of randomization. The small sample population comprised 28 patients, with a 95% confidence level for the patient's retention satisfaction rating from 1.3 to 30.8. Because of the wide range in the confidence interval, although statistical significance existed, we could not conclusively determine whether a meaningful clinical effect for the complete denture wearer with LO existed. It is felt that a larger randomized controlled trial is necessary to provide more precise and meaningful results.

Conclusion

Despite the limitations of a small sample size and a lack of randomization, this pilot study found that edentulous patients wearing complete dentures with LO experienced and expressed greater satisfaction with their denture retention than patients wearing complete dentures with BBO. However, the posterior occlusal scheme did not exhibit any significant effects on subjective satisfaction ratings for general satisfaction, stability, and ability to masticate, or on objective results for the number of adjustments and masticatory performance. In addition, it was observed that a higher alveolar ridge resulted in greater masticatory performance.

Acknowledgment

This study was undertaken with assistance from the Nihon University Research Grant for Assistants and Young Researchers and the Suzuki Memorial Grant of Nihon University School of Dentistry at Matsudo (Research Grant for Assistants).

References

1. Inoue S, Kawano F, Nagao K, Matsumoto N. An in vitro study of the influence of occlusal scheme on the pressure distribution of complete denture supporting tissues. Int J Prosthodont 1996;9:179–187.
2. Ohguri T, Kawano F, Ichikawa T, Matsumoto N. Influence of occlusal scheme on the pressure distribution under a complete denture. Int J Prosthodont 1999;12:353–358.
3. Takayama Y, Yamada T, Araki O, Seki T, Kawasaki T. The dynamic behaviour of a lower complete denture during unilateral loads: analysis using the finite element method. J Oral Rehabil 2001;28:1064–1074.
4. Floystrand F, Orstavik JS. Retention of complete maxillary dentures as a result of changes in design. Acta Odontol Scand 1984;42:327–332.
5. Clough HE, Knodle JM, Leeper SH, Pudwill ML, Taylor DT. A comparison of lingualized occlusion and monoplane occlusion in complete dentures. J Prosthet Dent 1983;50:176–179.
6. Arbree NS, Fleck S, Askinas SW. The results of a brief survey of complete denture prosthodontic techniques in predoctoral programs in North American dental schools. J Prosthodont 1996;5:219–225.
7. McGarry TJ, Nimmo A, Skiba JF, Ahlstrom RH, Smith CR, Koumjian JH. Classification system for complete edentulism. Dent Today 2001;20:90–95.

8. Kawai Y, Machida T, Gunji A, Kimoto S, Kobayashi K. Raliavility and validity of the Japanese version of the visual analog scale as an outcome measurement of complete denture prostheses Prosthodont Res Pract 2003;2:64–71.
9. Manly RS, Braley LC. Masticatory performance and efficiency. J Dent Res 1950;29:448–462.
10. Payne SH. A posterior set-up to meet individual requirements. Dent Digest 1941;47:20–22.
11. de Baat C, van Aken AA, Mulder J, Kalk W. "Prosthetic condition" and patients' judgment of complete dentures. J Prosthet Dent 1997;78:472–478.
12. Fenlon MR, Sherriff M. Investigation of new complete denture quality and patients' satisfaction with and use of dentures after two years. J Dent 2004;32:327–333.
13. Wolff A, Gadre A, Begleiter A, Moskona D, Cardash H. Correlation between patient satisfaction with complete dentures and denture quality, oral condition, and flow rate of submandibular/sublingual salivary glands. Int J Prosthodont 2003;16:45–48.
14. Awad MA, Feine JS. Measuring patient satisfaction with mandibular prostheses. Community Dent Oral Epidemiol 1998;26:400-405.
15. Ono K, Hatake S. A study on the form of occlusion in denture wearers: The effect of lingualized occlusion on masticatory function. Shigaku 1988;76:107–137.
16. Gomibuchi T, Koide K, Hatake S. Masticatory function between lingualized occlusion and full balanced occlusion. J Jpn Soc Prosthodont 2000;44:339–347.
17. Kimoto K, Garrett NR. Effect of mandibular ridge height on masticatory performance with mandibular conventional and implant-assisted overdentures. Int J Oral Maxillofac Implants 2003;18:523–530.
18. Garrett NR, Kapur KK, Perez P. Effects of improvements of poorly fitting dentures and new dentures on patient satisfaction. J Prosthet Dent 1996;76:403–413.