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Editorial

Experience has forged lessons of self-improvement, wisdom, and expectations for prosthodontists. Furthermore, strength in faith and determination has led to tremendous growth over 30 years.

As the founding member, it is my honor to serve as a committee member and dedicate myself to the Academy.

There are no short cuts to success. It is a direct result of preparation, hard work, and lessons learned from failure. A reflection of the past helps one to understand the present.

In this volume, we reflect on two original studies and two case studies.

Case reports serve to increase judgment through experience. In place of studies such, the experiences provide the basis to amass measures for further dental practices.

As the aforementioned articles are worth reading, it gives me great pleasure to share this issue with you. We are also pleased to share with you additional information of importance. As of March 2020, all JPI articles with registered DOI can now be found online at the Airiti Library.

Lastly, it is with great appreciation to all participants that I say, we look forward to additional distinct articles for the benefit of all prosthodontists.

Hsiu-Na Lin
Editor-in-Chief

Original Article

Assessment of oral stereognostic ability of healthy adults

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Abstract

Purpose: *A novel method for assessing oral stereognostic ability (OSA) in the older people was developed. The association between OSA and age, oral functions as masticatory performance and subjective chewing experience, were investigated.*

Materials and methods: *Testing objects fabricated by self-cured resin were designed in different thickness and diameter to assess the OSA, five discs were used for assessment, two trials were performed, accuracy and reaction time were recorded. Color-changeable chewing gum was adopted to quantify masticatory performance. Subjective experience of chewing was assessed by questionnaire translated into Chinese. Statistical correlation and comparison were performed in each variable.*

Results: *Twenty-four subjects completed OSA (11 males and 13 females, mean age: 34.5 years-old) were recruited. The correlation in accuracy between the first and the second tests did not reach a statistical significance (Spearman's rho = 0.051, p = 0.482). Between the two tests, the accuracy did not differ significantly (two-tailed Wilcoxon signed-rank test, p = 0.061).*

The correlation in reaction time between the first and the second tests reached a statistical significance (Spearman's rho = 0.786, p < 0.001). Between the two tests, the reaction time showed a significantly difference (two-tailed Wilcoxon signed-rank test, p = P = 0.028). The correlation between OSA accuracy and masticatory performance was not statistically significant (the first test: Spearman's rho = 0.301, p = 0.275; the second test: Spearman's rho = 0.114 p = 0.685).

Conclusion: *The current study reported a novel assessment of evaluating OSA, which revealed a high consistence in between-test reaction time, as an index of OSA performance.*

Key words: Color-changeable chewing gum, experience of chewing, masticatory performance, oral stereognostic ability

Introduction

When age increases, the human teeth reduce its number due to decay, periodontal disease[1]. The increased number of missing teeth would substantially influence individual ability in mastication, e.g., a decrease in masticatory performance[2, 3]. Critically, not only the oromotor ability but also the sensory ability can be compromised due to aging[4-6]. It's critical to discriminate the size and location of bolus, which means oral perception, and to coordinate with the muscular system in the masticatory process. If the perceptive or coordination ability decreases, it will disturb denture adaptation and may lead to mistrust to the clinicians. The ability of sensing the size and form of intraoral objects, namely, the oral stereognosis[7], has relatively been ignored in the literature. The association between oral stereognosis, masticatory performance, aging, and experience of feeding, has not been fully studies.

The "stereognosis" is to discriminate the shape, size or texture of an object by contact. The oral stereognosis is to achieve this process in the oral cavity[8]. Previous studies suggested that the oral stereognostic ability decreases with age[5, 6, 9, 10], but worse oral stereognostic ability does not correlate to worse masticatory performance[11]. In addition, the study with palatal coverage did not reveal the correlation between oral stereognosis with masticatory performance [12, 13]. All these studies suggest complicated relationship between oral stereognosis, chewing function and age.

Until now, several methods have been proposed to assess the oral stereognostic ability (OSA). In general, a test object is put into the subject's mouth, and the subject needs to sense the shape of the object and makes a correct judgment on its size or form. The accuracy of the judgment and/or the reaction time to make a correct judgment was quantified, as the index of OSA[5, 13, 14]. These oral stereognostic assessment can be further Classified into two categories: (a) the assessment of the form of the objects, which may differ in their geometric form (e.g. triangle or square)[5, 12, 13], and (b) the assessment of the size of the objects, which may vary from small to large[15]. Until now, there has not been a standardized method for assessing OSA.

Based on the previous research, in the current study, a novel method for assessing OSA in the older people was reported. The method adopted an older people-friendly object, which was designed similarly to a drug pill. OSA was indexed as the accuracy and reaction time to make a correct judgment on the size of the pill. The association between OSA and age, oral functions as masticatory performance and subjective chewing experience, were investigated as the following objectives:

1. It was hypothesized that the novel method showed a good reliability between two tests. Specifically, across the subjects, the accuracy and reaction time (i.e., the OSA performance) between the first and second test would be significantly correlated.
2. The association between the OSA performance and age, masticatory performance, and the experience of chewing were investigated.

Materials and methods

Study sample

The current study is designed as a cross-sectioned observational research based on healthy adults, who were physically and mentally healthy, between 20 to 85 years-old and were able to understand and cooperate with the experiments. The study was examined and reviewed by the internal review board of National Yang-Ming University (YM104028E). Written informed consent was received from all the subjects before the study began.

Assessment of oral stereognostic ability (OSA)

The design of the testing objects was modified according to the method from a previous study[15]. The testing objects were fabricated by instilling self-cured resin (ALIKE™ Temporary Crown & Bridge Resin, GC America) into customized molds (Fig.1). The molds were specifically designed as a disc-like shape, with 8, 10, 12 mm in diameter and 2, 3, 4 mm in thickness. In total, nine different resin-based discs were fabricated for each subject. Each disc was attached with a piece of dental floss so that the subject may not swallow the disc accidentally[5].

After the test object was put into mouth, the subject was instructed to estimate size of the testing object and give an answer by matching the testing object visualized on an 'answer board' (Fig.2). Notably, the subjects were not allowed to see the testing objects nor could they touch the objects. Five

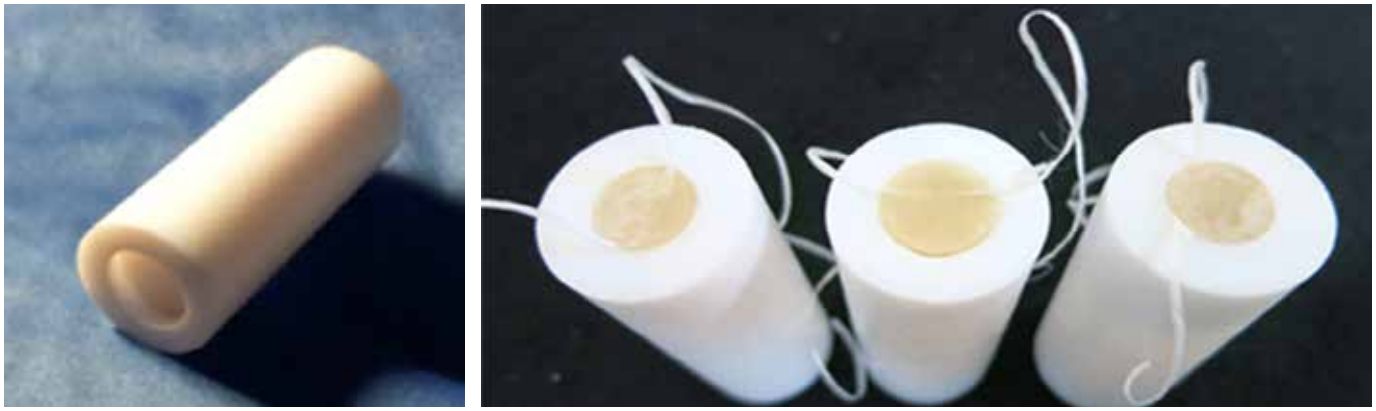

Figure 1. The Teflon mold and fabrication of testing discs.

of the testing discs (No.1, 3, 4, 8, 9 in Fig.2) were used for the assessment. Two trials were performed for each subject. The OSA performance was quantified as (a) the accuracy that the subject correctly answered the size (i.e., the proportion of the correct answer to the total number of testing) and (b) the response time of giving the answer (i.e., the time-delay between putting the object into mouth and giving the answer).

Masticatory performance

Masticatory performance was assessed based on the method using a color-changeable chewing gum[16], a widely used method for assessing the oral mixing ability[16]. In general, the subjects were asked to chew the gum (XYLITOL, Lotte Co., Ltd., Tokyo, Japan) for three minutes. The chewed gum was then digitalized by a scanner and its colorimetric properties (i.e., the L*, a* and b* value from the CIELAB color space) were assessed digitally[17]. Masticatory performance was quantified as the change in the color space (ΔE) between the chewed gum and un-chewed gum[18].

Experience of chewing

The subject's experience of chewing was assessed using the self-rating questionnaire, which composed of the questions modified from a previous study[19]. The questions are '*Is there any food which you have difficulty to chew and therefore avoid to eat?*', '*Do you feel dryness in your mouth?*', '*Do you get food stuck in the throat?*', '*Does it take longer time for you to finish a meal than for other people?*'. All the questions were answer by 'yes' or 'no'.

Statistical methods

The normality test revealed a non-normal distribution of the research variables (Table 1). Therefore, non-parametric methods were adopted for statistical analyses. Wilcoxon signed-rank test was conducted for a within-subject comparison between two tests. Mann-Whitney U test was conducted for between-group comparison. Spearman's rho coefficient was calculated for quantifying the association between variables.

Figure 2. Answer board for the OSA test.

Results

Descriptive statistics

Twenty-four subjects completed oral stereognosis assessment (11 males and 13 females, mean age: 34.5 years-old) were recruited. Among the subjects, 15 subjects completed all the tests (4 males and 11 females, mean age: 39.1 years-old). The results of the descriptive analyses were summarized in Table 1.

The accuracy of oral stereognosis assessment

The correlation in accuracy between the first and the second tests did not reach a statistical significance (Spearman's rho = 0.051, p = 0.482). Between the two tests, the accuracy did not differ significantly (two-tailed Wilcoxon signed-rank test, p = 0.061) (Fig.3).

The response time of oral stereognosis assessment

The correlation in reaction time between the first and the second tests reached a statistical significance (Spearman's rho = 0.786, p < 0.001). Between the two tests, the reaction time showed

Table 1. Results of descriptive analyses.

	Max.	Min.	Median	Mean	S.D.	Normality[1]
Accuracy (%) (n=24)						
1st test	100	20	40	50	22.4	0.008
2nd test	100	20	60	64	25.8	0.034
Reaction time (seconds) (n=24)						
1st test	33.2	2.8	10.9	12.4	7.7	0.031
2nd test	20.0	3.0	7.3	9.6	5.0	0.023
	Max.	Min.	Median	Mean	S.D.	Normality[1]
Masticatory performance (ΔE) (n=15)						
	XX	XX	XX	XX	XX	XX

[1]Shapiro-Wilk test was performed for normality test. The P value < 0.05 indicates that the data were distributed non-normally.
OAcc: Accuracy of OSA, Rt: reaction time.

a significantly difference (two-tailed Wilcoxon signed-rank test, p = P = 0.028) (Fig.4).

Association with masticatory performance:

The correlation between OSA accuracy and masticatory performance was not statistically significant (the first test: Spearman's rho = 0.301, p = 0.275; the second test: Spearman's rho = 0.114 p = 0.685).

Subjective chewing experience:

All the subjects completed both the OSA and the questionnaire. As shown in Table 2, for each question, the accuracy and reaction time of the OSA test did not significantly differ between the subjects who answered 'yes' and those who answered 'no' (two-tailed Mann-Whitney U test p > 0.05).

Discussion

Major findings of the current study

The current study reported a novel assessment of evaluating OSA. The results indicated partly confirming the hypothesis that the reaction time showed a consistency between the first and the second tests (Fig.4); while the accuracy did not show such a good consistency (Fig.3). Both the accuracy and reaction time did not differ between the two tests, suggesting a consistency between tests.

The OSA performance, however, were not significantly associated with the objective assessment (masticatory performance) and the subjective assessment (self-reporting questionnaire) of chewing (Table 2). The results were discussed as follows.

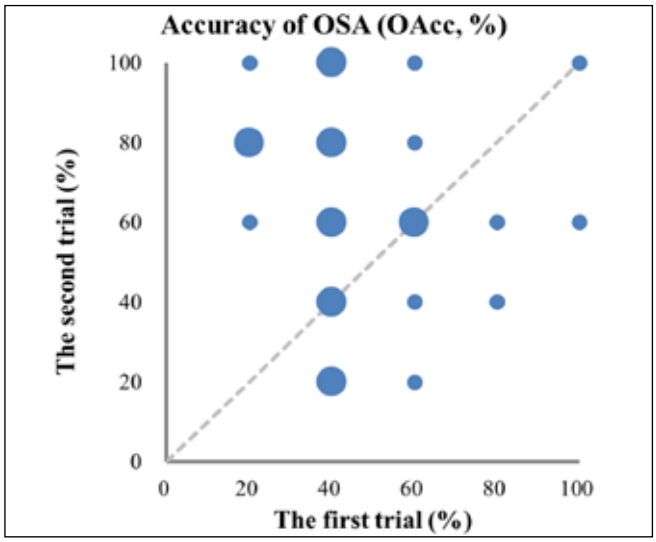

Figure 3. Correlation and comparison of two trials of OSA accuracy. Wilcoxon signed-rank test: P = 0.061, Spearman's rho = 0.051, P = 0.482.

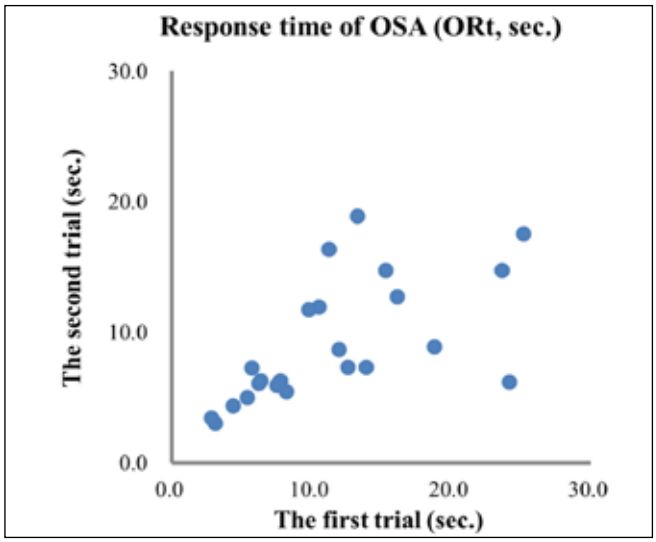

Figure 4. Correlation and comparison of two trials of OSA response time. Wilcoxon signed-rank test: P = 0.028, Spearman's rho = 0.786, P = 0.000.

Table 2. Subjective chewing experience and OSA accuracy and response time. Mann-Whitney U test was performed for analysis.

	Accuracy (%)		Reaction time (sec)	
Questions	1st test	2nd test	1st test	12nd test
Is there any food which you have difficulty to chew and therefore avoid to eat?				
No (n=13)	40	60	11.2	11.8
Yes (n=11)	4	8	8.2	6.
	p=0.865	p=0.252	p=0.820	p=0.228
Do you feel dryness in your mouth?				
No (n=11)	40	60	8.2	7.3
Yes (n=13)	40	60	11.2	8.7
	p=0.303	p=0.424	p=0.303	p=0.361
Do you get food stuck in the throat?				
No (n=10)	50	60	7.2	6.8
Yes (n=14)	40	70	11.6	8.0
	p=1.000	p=0.709	p=0.472	p=0.403
Does it take longer time for you to finish a meal than for other people?				
No (n=8)	50	60	12.2	14.8
Yes (n=16)	40	70	10.1	6.8
	p=0.569	p=0.742	p=0.742	p=0.093

Oral stereognosis: an issue remained unclear

A critical step in human feeding behavior is to discriminate the size and location of bolus, which means oral perception, and to coordinate with the muscular system in the masticatory process[20]. If the perceptive or coordination ability decreases, it may disturb denture adaptation and may lead to mistrust to the clinicians. One of the key oral perceptive abilities is the oral stereognosis. The "stereognosis" is to discriminate the shape, size or texture of an object by contact. The oral stereognosis is to achieve this process in the oral cavity[8].

Previous studies suggested that the oral stereognostic ability decreases with age[5, 6, 9, 10], but worse oral stereognostic ability does not correlate to worse masticatory performance[11]. In addition, the study with palatal coverage did not reveal the correlation between oral stereognosis with masticatory performance[12, 13]. The accuracy of OSA improved statistically with palatal coverage[21], it was inferred that the tongue perceived the spheres more precisely than palate, the tongue rolling the objects on a solid surface may be crucial to oral stereognosis[21]. But other researchers did not report the consistent findings[12, 13]. Improved OSA was also observed in the elder participants after wearing complete dentures[5]. Finally, most literature showed that older subjects have worse OSA[4, 5, 9.] All these studies suggest complicated relationship between oral stereognosis, chewing function and age.

How to quantify OSA performance: by accuracy or by reaction time?

The results revealed high between-test correlation in response time but not in the accuracy. The findings suggested that reaction time, which is associated with one's processing of perception and decision-making, could be a better index for OSA performance. In contrast, the accuracy may be more vulnerable to the learning effect, i.e., an improvement in giving correct answer in the second test, compared to the first test. As shown in our results, comparing the first and the second trial, the accuracy increased (median accuracy from 40% to 60%) and the response time decreased (reaction time from 10.9 sec to 7.3 sec), which implied that the subjects become more familiar to the experiment and had better performance in the second test.

Interestingly, even with the potential learning effect, the subjects showed between-test consistency in reaction time. The findings suggested that reaction time, as an index for OSA performance, may be dominated by the psychological factors other than perception per se. For example, a scrutinous subject may perceive each testing object very carefully when giving an answer; in contrast, an impatient subject may give the answer quickly based on his or her instinct. The association between these psychological factors (e.g., personal traits) and the OSA performance would require more investigation in the future.

Association between OSA and chewing ability

No significant correlation between the OSA score and the results from assessment of mastication were revealed. In terms of the masticatory performance, the lack of a significant correlation may be accounted by the distribution of the scores: in the results, the variation of masticatory performance was small, and therefore the association between masticatory performance and the OSA performance was less pronounced. Another important reason is the method for testing masticatory performance. In the previous study that reported a high correlation[22], the masticatory performance was quantified by assessing the ability to cutting/crushing the standardized food[8, 14]. This ability of cutting/crushing food is different from the oral mixing ability, as assessed using color-changeable chewing gum[23]. The difference between these two abilities may lead inconsistent results in different studies.

In terms of the subjective experience of chewing, the results can be biased by the fact that most of the subjects were younger adults, who would find fewer difficulties during chewing. It should be noted that even in older subjects, there could still be an inconsistence between the subjective rating of chewing and the score from objective assessment, since the subjective experience is shaped by long-term experience of feeding, and the subjects may already adapt to their oral conditions.

Limitations and clinical implications

The current study introduced a novel method for assessing OSA. Still, the results should be carefully interpreted. First, the insignificant findings may be associated with the existence of Type II error, which was further associated with the number of sample size. Secondly, the results revealed that reaction time, a widely used index for evaluating performance, may be associated with individual personal traits. The psychological factors underlying OSA performance would require future investigation. One of the commonest ways to restore is wearing removable dentures, but the clinicians still have to deal with several challenges: some patients to the intraoral fixed prosthesis, or some patients could not adapt to well-designed removable dentures. First, the chewing ability may decrease due to degenerated muscular activity and strength with age[3, 24, 25]. Second, the denture adjustment should accord to the subjective wearing feedback from the patient, the clinicians could not adjust the denture efficiently if the patients could not express themselves explicitly. Finally, according to the up-date neuroscientific evidence, mastication is not only a pure muscular exercise, but a complicated coordination between movement and sensation, to achieve better chewing efficiency[26, 27].

Conclusion

The current study reported a novel assessment of evaluating OSA, which revealed a high consistence in between-test reaction time, as an index of OSA performance. The accuracy of the OSA test was not significantly associated with the objective assessment (masticatory performance) and the subjective assessment (self-reporting questionnaire) of chewing.

Conflict of interest

The authors declared no conflict of interest.

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Original Article

The altered amplitudes of temporomandibular joint vibrations during swallowing in oral cancer patients with oronasal communication before and after obturator rehabilitation: a pilot study

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Abstract

Purpose: *This study investigated the association between obturator rehabilitation and the amplitude of temporomandibular joint (TMJ) vibration during swallowing in oral cancer patients with oronasal communication.*

Materials and methods: *Oral cancer patients treated with obturator rehabilitation to close an oronasal fistula following tumor excision were enrolled in this study. Each of the patients was asked to swallow three times independently without and with the obturator in place, while electrosonography (ESG) (K7 sonography; Myotronic Inc.) was used to record the amplitude of TMJ vibration. Statistical analysis was performed using IBM SPSS Statistics, version 20.0, with the results compared using the Wilcoxon signed-rank test and $P<0.05$ considered to indicate a statistically significant difference.*

Results: *Ten patients with oronasal communication, including three females and seven males, participated in this study. Their mean age was 39.4 years old (range: 32 to 63 years old). Their average amplitude (Avg) values of TMJ vibration were 76.81 ± 0.52 and 77.93 ± 0.91 when wearing and not wearing an obturator, respectively. According to these results, utilizing an obturator to close the oronasal communication significantly impacted the amplitude of TMJ vibration during swallowing in these oral cancer patients ($P < 0.005$).*

Conclusion: *Compared to oral cancer patients with oronasal communication who have not received obturator reconstruction, such patients fitted with an obturator might have significantly different TMJ movements during deglutition. Relatedly, future studies could compare the physical swallowing patterns of patients with an intact palate before tumor excision to those of the same patients after obturator reconstruction to determine what differences, if any, there are.*

Key words: Obturator, Oronasal communication, Swallowing, TMJ vibration

Introduction

The surgical extirpation of a maxillary cancerous area often results in oronasal communication. The maxillary defect usually significantly impacts post-treatment oral functions[1], including intake, swallowing, pronunciation, and chewing ability[2]. Deglutition is a complicated function controlled by multiple oral muscles and structures, such as the maxilla, mandible, tongue, dental components, temporomandibular joints (TMJ), and masticatory muscles[3]. The TMJs are involved in the actions of mouth opening, closing, and mastication in the oral stages of swallowing patterns. A previous study indicated that TMJ disorder (TMD) has negative impacts on the swallowing function[4]. However, previous studies have rarely tracked the trajectory of the TMJs during swallowing, because the movement of the TMJs during swallowing is very slight and thus difficult to record.

It is necessary to seal any oronasal communication to accelerate food bolus transfer from the oral cavity to the pharynx[5]. The use of an obturator to close a maxillary defect can not only close the oronasal communication but can also rehabilitate the swallowing function and decrease the swallowing time. In the past, the recovery of oral function after obturator reconstruction was typically investigated by surveying the subjective responses of patients through questionnaires, whereas the actual changes to deglutition patterns due to the sealing of oronasal communications have been less investigated.

The vibrations of the TMJ can be used to represent different joint conditions[6]. There are many sounds that are emitted during TMJ movement, especially when there are some internal derangements of the joint[7]. Past studies have reported that the average amplitude of such sounds is higher in subjects with at least one symptom or sign of TMD[8]. Previous studies have further found that the presence of a peak-shaped track in electrosonography (ESG) results has high specificity in detecting articular disc displacement with reduction[9,10],while still another previous study utilized the kinematics of the mandible and the condyles to determine the actual movement paths and positions of the mandible and condyles during the process of swallowing[11]. Hence, this study utilized TMJ vibration sounds to determine mandibular movements during deglutition. More specifically, we tried to estimate the altered amplitudes of TMJ vibrations during deglutition to represent the changes in swallowing patterns of patients with oronasal communication when fitted with and not fitted with an obturator. This study preliminarily utilized TMJ vibration sounds to determine the changes in swallowing patterns after obturator rehabilitation.

The purpose of this study was to compare the TMJ movements during swallowing in patients with oronasal communication when wearing or not wearing an obturator.

Material and methods

A total of ten people participated in this pilot study, including three females and seven males. Their mean age was 39.4 years old (range: 32 to 63 years old). All of the subjects had undergone chemotherapy and radiotherapy after tumor excision from 2017 to 2019. The patients all suffered from oronasal communication after their surgeries and thus received obturator reconstruction. Because missing teeth may affect oral functions, only subjects with fully intact dentition were included in the study, while participation was further limited only to those with a Class III Aramany Classification of maxillary defect[12]. All the subjects received obturator rehabilitation to close their oronasal communications, and they all had clear consciousness and were able to perform swallowing following instructions. Any individuals with stroke history, temporomandibular disorder, neuromuscular disease, or any symptoms of dysphagia were excluded from this study. The TMJ sounds during swallowing were evaluated by ESG (K7 sonography; Myotronic Inc.). This equipment was used to determine the sounds of TMJ vibrations. It is composed of a headset that holds highly sensitive vibration transducers over each TMJ and simultaneously captures bilateral tissue vibrations resulting from joint sounds. The sounds of TMJ vibrations are accompanied with mandibular movements, and provide valuable information for assessing TMJ functions. Utilizing ESG to detect TMJ vibrations during swallowing is a non-invasive form of evaluation (Fig.1).

The participants were asked to swallow three times independently when not wearing an obturator. The final data was represented as the average of the three values. The patients all

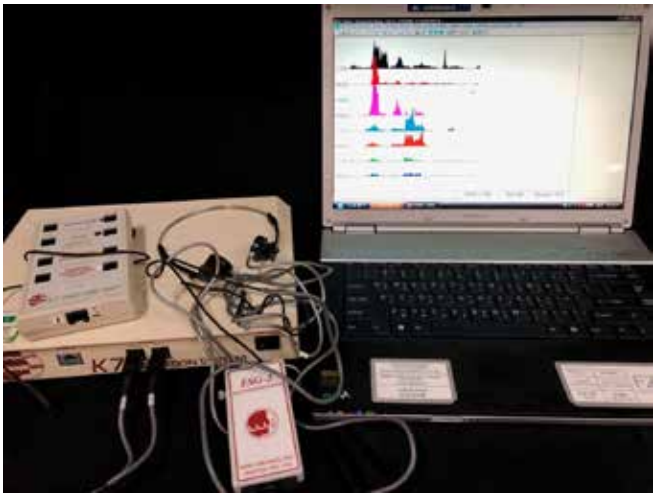

Figure 1. ESG (K7 sonography; Myotronic Inc.) composites made with a lightweight headset that holds highly sensitive vibration transducers over each TMJ, enabling the simultaneous, bilateral capture of tissue vibrations resulting from joint sounds.

received an interim obturator over six months after their excision wound had become stable, and all the obturator rehabilitations were performed by the same prosthodontist. After the permanent obturators had been delivered and used for over three months and a clinician had ensured that the patients had adapted well to their obturator, the ESG assessment was performed again with all the subjects when they were wearing their obturators. To relieve the xerostomia resulting from having undergone radiotherapy, all the participants were asked to drink water before swallowing. The amplitudes of the TMJ vibration sounds during deglutition were thus ultimately recorded using ESG when the patients were both wearing and not wearing their obturators.

Comparisons of the results for the subjects when wearing and not wearing obturators were made using the Wilcoxon signed-rank test. The analyses were performed using IBM SPSS Statistics, version 20.0, and $P < 0.05$ was considered to be statistically significant.

Results

The average amplitudes of TMJ vibrations in the participants when wearing and not wearing an obturator were 76.81 ± 0.52 and 77.93 ± 0.91, respectively. The difference in the average amplitudes when wearing and not wearing obturators was significant ($P < 0.001$) (Table 1).

Table 1. Comparison of the average amplitudes of TMJ vibrations during swallowing before and after obturator rehabilitation by Wilcoxon signed-rank test.

N=10	Before (Mean±SD)	After (Mean±SD)	*P*-value
Avg	77.93±0.91	76.81±0.52	0.000**

Note: Before = Before obturator rehabilitation, After = After obturator rehabilitation, Avg = the average amplitude of TMJ sounds. ** $P < 0.001$.

Discussion

A previous study indicated that obturator rehabilitation, which is a reliable treatment modality, can reduce nasal regurgitation, hypernasal speech, and the time of swallowing, in addition to improving speech, articulation, deglutition, and mastication[13]. The results in this study showed that the average amplitudes of TMJ sounds were significantly different when the subjects wore their obturators as compared to when they were not wearing them. From this result, it can be inferred that obturator reconstruction might change the TMJ movements during swallowing in those with oronasal communication in comparison to those with oronasal communication who have not had obturator reconstruction. However, this study still could not prove that obturator reconstruction is able to effectively improve swallowing patterns because the amplitudes of the TMJ vibrations during deglutition before oral surgery in subjects who had intact soft and hard palates were not estimated. Otherwise, the participants were all restricted to individuals with Aramany Class III maxillary defects because such patients can utilize their tongues to seal any oronasal communication during swallowing, and this restriction may have caused bias in the results. That said, the mandibular trajectory in a swallowing pattern might be changed after obturator reconstruction, and based on the findings of this study, it would be interesting to measure the amplitudes of TMJ sounds during swallowing before tumor excision, as such measurements might be regarded as a reference for the recovery of swallowing function after obturator reconstruction. In future studies, the

enrolled subjects should thus include patients with various Aramany Classifications of maxillary defect to increase the realism of said studies.

This retrospective pilot study had some limitations, such as a small sample size. However, while the sample size was small, future investigations can still use the findings of this study as a reference for further discussions. Another limitation, meanwhile, was that the initial swallowing patterns and TMJ movements before tumor excision were not recorded. That said, the pre-surgical records of TMJ vibrations during swallowing could be used for comparison to confirm the inference of this study. In clinics, oral function evaluations are typically restricted to subjective estimations, but whether the amplitudes of TMJ vibrations can be regarded as a reference to evaluate the swallowing function in the future is worthy of further discussion.

Conclusion

The results of this study suggest that patients with oronasal communication who have undergone obturator reconstruction have significantly different amplitudes of TMJ vibration during swallowing compared to those with oronasal communication without obturators, with the TMJ movements during deglutition being greatly altered after obturator rehabilitation. Relatedly, it would be of interest to investigate whether the amplitudes of TMJ sounds during deglutition can be considered as physiological references indicating the recovery of the swallowing function in oral cancer patients with oronasal communication. To perform such an investigation, larger sample sizes and recordings of the initial statuses of the swallowing patterns of patients are needed in future research.

Acknowledgment

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Conflicts of interest

None.

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Case Report

Application of rotational path removable partial dentures for a Kennedy Class II partially edentulous patient: a case report

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Abstract

This report presents a case of using rotational path partial denture design to treat Kennedy Class II patient. The designs of rotational path of insertion are different for maxillary and mandibular arches in this case. For the maxillary arch, the rotational path design belongs to category II, lateral insertion type. During inserting the denture, the undercut on tooth 23 (maxillary left canine) was engaged in an initial straight-path placement. Then the remainder of the denture rotated to its final position along with a rotation axis run through the cervical area of tooth 23 buccal surface and perpendicular to the tooth 16 (maxillary right first molar). For the mandibular arch, the rotational path design belongs to category I, lateral insertion type. During insertion of the mandibular denture, the buccal clasp on tooth 37 (mandibular left second molar) was placed first, then the remainder of the denture rotated along with a rotation axis run through the buccal clasp tip on tooth 37 and perpendicular to the direction of tooth 45 (mandibular right second premolar). Finally, the minor connector engaged the undercut on tooth 37 mesiolingual surface, when the whole denture was completely seated.

Key words: distal extension removable partial denture, Kennedy Class II patient, rotational path of insertion

Introduction

The rotational path of insertion has been applied to removable partial denture (RPD) for over several decades[1,2]. Although many clinical situations was illustrated in the literature indicated for the application of rotational path of insertion[3-5], it is still overlooked by the dental profession. The reason may be the lack of detail discussion of the rationale of the design and the sensitivity of laboratory techniques[3]. The most common cases reported in literature are tilted mandibular molars and missing anterior teeth, and both of them are tooth-borne situation[6-12].

There is a widespread misunderstanding that the rotational path design only can be used in tooth-borne RPD. In fact, the rotational path design was initially applied to distal extension case[13]. A case report[4], published by Dr. Donovan in 2008, revealed prosthodontic rehabilitation in a Kennedy Class II patient with unilateral posterior edentulous segment. In that case report, by using rotational path RPD, unsightly clasp assembly was eliminated and a favorable esthetic result was provided. Thus it will be realized that rotational path RPD design was not restricted in tooth-borne case.

Although implant could be used in many difficult prosthodontic rehabilitations, there are still some contraindications, such as poor bone quality or quantity, uncontrolled medical condition and insufficient economic ability. Therefore, RPD is still a common treatment option for compromised patients. According to the statistics of RPD cases, the number of distal extension RPD is greater than tooth-bore RPD[14]. Generally, in removable partial denture design, conventional path of insertion is the first choice. However, in some clinical situations such as unsightly direct retainer or severely tilted abutment, a rotational path design being an optional choice may provide a better clinical result.

Case report

The patient, 52-year-old male, was a 30-year heavy smoker with obstructive sleep apnea and received treatment in the Department of Chest Medicine, Keelung Chang Gung Memorial Hospital. He had been extracted many teeth at local dental clinic (LDC) and worn a RPD, but he was unable to adapt the RPD. Then he was referred from LDC to our hospital for tooth 13 endodontic retreatment and full mouth prosthodontic rehabilitation.

The remaining teeth in maxillary dentition are tooth 16,15,13 and 23 and in mandibular dentition are tooth 37, 36, 34, 33, 41, 42, 43, 44. Occlusal analysis revealed vertical dimension loss, tooth 33, 34 distal tilting, tooth 34 migration and tooth 41, 42 super-eruption.

Tentative treatment plan was discussed with the patient. Treatment began with tooth 13 endodontic retreatment. Then the casting posts and temporary crowns over tooth 13 and tooth 23 were fabricated under the vertical dimension determined by a diagnostic wax up. Maxillary interim denture was fabricated to evaluate the lost vertical dimension and the denture adaptability of the patient. The fit, the length and the thickness of the palatal plate of the denture was adjusted. In a three-month follow up period, full mouth periodontal treatment and general dental treatment was performed. Lack of gag reflex to the interim denture was confirmed (Fig.1).

Then, definite prosthetic treatment was began. Preliminary impression was made by irreversible hydrocolloid (Cavex CA37®, Cavex, Holland) and study casts were poured in Type

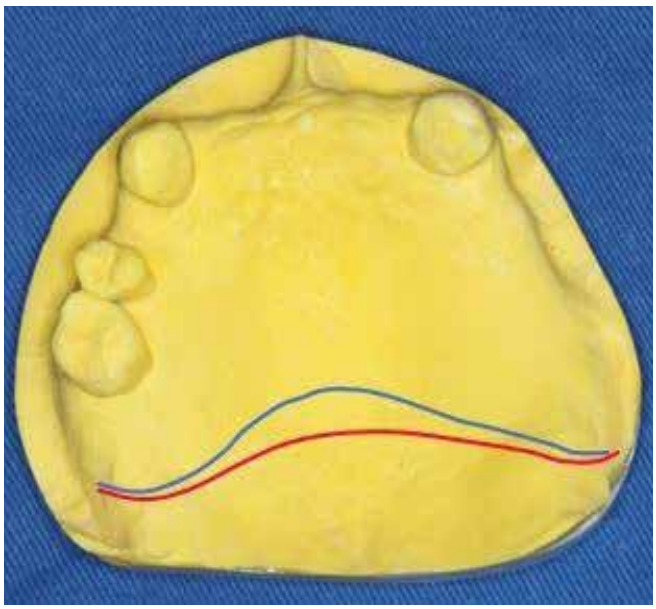

Figure 1. Red line: initial palatal coverage of interim denture; Blue line: adjusted palatal coverage.

II dental stone (Super hard stone®, Taiwan) for model survey. Final teeth preparation and final impression for tooth 13 and tooth 23 surveyed crowns with addition reaction silicone impression material (Examixfine®, GC, Japan) and master cast poured in Type IV dental stone (Silky Rock®, Whip Mix Corporation, USA) was performed. The recording base and occlusal rim was made to check vertical dimension. Then take interocclusal record with Aluminum wax (Aluwax Dental Products Company, USA) and facebow transfer for maxillary and mandibular casts mounting. After maxillary and mandibular casts mounting in articulator, resin tooth arrangement around tooth 13, 23 (Fig.2A, 2B) and maxillary cast survey (Fig.2C, 2D, 2E) was taken for tooth 13, 23 surveyed crown fabrication. Cingulum rest seats were designed on the palatal side of tooth 13, 23 and undercut was designed on buccal surface of tooth 23.

Preliminary impression was made again after tooth 13, 23 porcelain fused to metal (PFM) crowns permanent setting and study cast was poured for models survey and custom trays fabrication. After tooth preparation on abutment teeth and border molding of individual trays, final impression was made by using additional reaction silicone impression material (Examixfine®, GC, Japan). Maxillary and mandibular master casts were poured in Type IV dental stone (Silky Rock®, Whip Mix Corporation, USA).

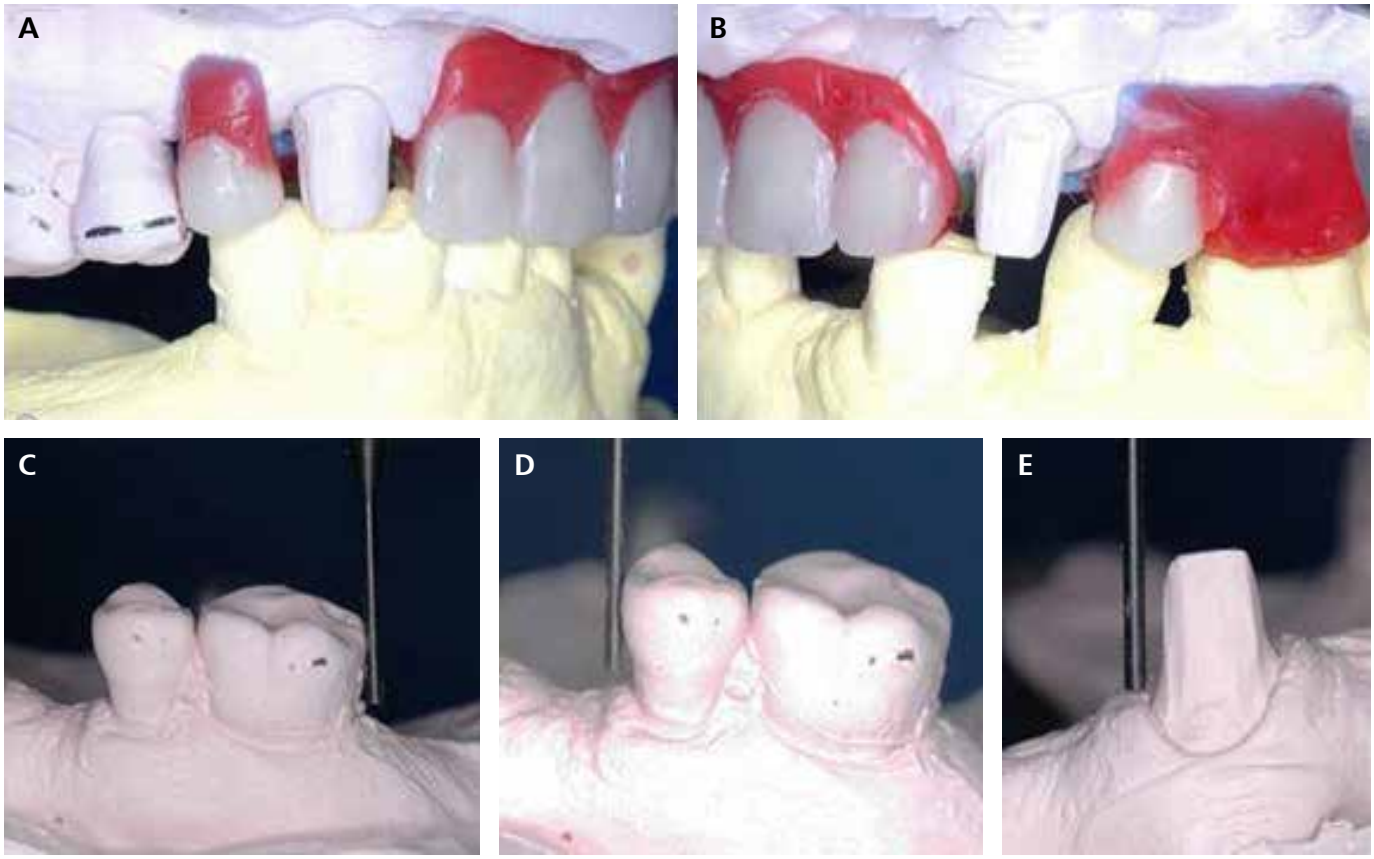

Figure 2. A, B: resin tooth arrangement to check tooth 13, 23 teeth preparation, C, D, E: survey for surveyed crown fabrication.

Maxillary denture framework was designed with circumferential clasp on tooth 16, wrought wire circumferential clasp on tooth 23 and a palatal plate as a major connector. And the palatal coverage was determined by the interim denture. The cingulum rests on tooth 13, 23, mesial occlusal rest on tooth 15 and distal occlusal rest on tooth 16 were fabricated on the rest seats (Fig.3). It is notable that the clasp tip on tooth 23 did not engage undercut, and the retention of tooth 23 buccal clasp is from the rigid portion of clasp root (Fig.3B).

Mandibular denture framework was designed with wrought wire circumferential clasp on tooth 44, embrasure clasp on tooth 36, 37 and a lingual plate as a major connector. The cingulum rests on tooth 33, 41, 42, 43, distal occlusal rest on tooth 34, mesial occlusal rests on tooth 36, 44 and interproximal occlusal rest on tooth 36, 37 were fabricated on the rest seats (Fig.4). It is notable that after surveying, tooth 45 lingual surface was blocked out (Fig.4D,4E) with a specially designed block-out instrument[15] according to designed rotational path of insertion (Fig.4A). The framework was waxed, cast in chrome-cobalt alloy and returned for framework try-in (Fig.5).

At the try-in appointment, framework stability was checked. For the maxillary framework, the distobuccal undercut on tooth 23 was engaged first and then the framework was rotated so that the clasps on tooth 16 and rest seats on tooth 16, 15, 13, 23 seated completely (Fig.6). For the mandibular framework, the rotational center on tooth 37 is seated first, followed by the undercut on tooth 36, 37, rest seats on tooth 34, 33, 41, 42, 43, 44 and wrought wire circumferential clasp on tooth 44 of the framework (Fig.7). A facebow transfer record was taken, and an interocclusal record was made. The casts were mounted in a semi-adjustable articulator and returned to the laboratory for resin tooth arrangement according to the shade determination (Fig.8). After wax dentures try-in, the casts were returned to the laboratory again with instructions for processing.

The finished RPDs were inserted with denture base and occlusal adjustment (Fig.9). The esthetic results were better with less obvious clasp assembly on tooth 23 and the other clasp assemblies were located too posterior to be visible. The use of rotational path design permitted a conservative, esthetic and stable denture for this Kennedy Class II edentulous patient.

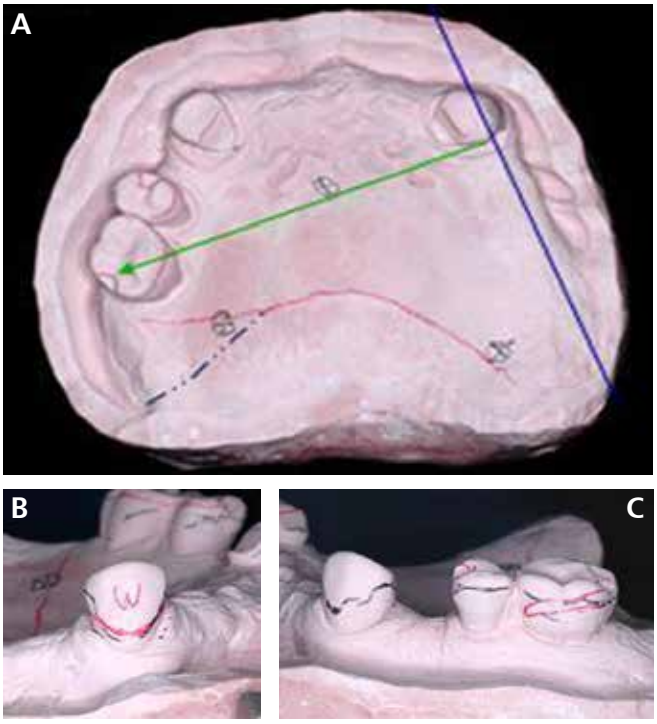

Figure 3. A: Path of RPD insertion;
B: wrought wire circumferential clasp design on tooth 23;
C: Circumferential clasp design on tooth 16.

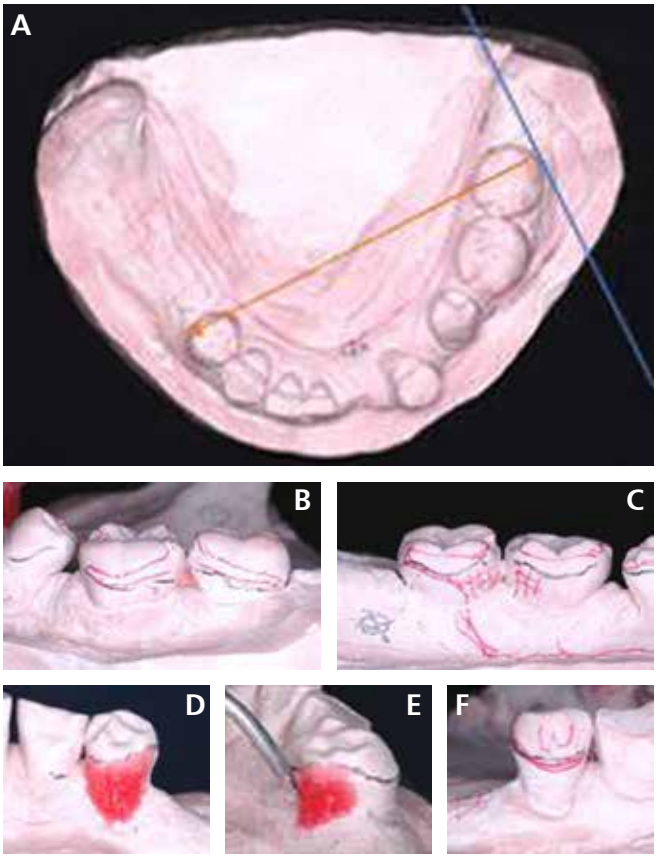

Figure 4. A: Path of RPD insertion;
B: Circumferential clasp on tooth 36, 37;
C: undercut on tooth 37 lingual side stay intact;
D, E: block out on tooth 45 lingual surface;
F: wrought wire circumferential clasp on tooth 45.

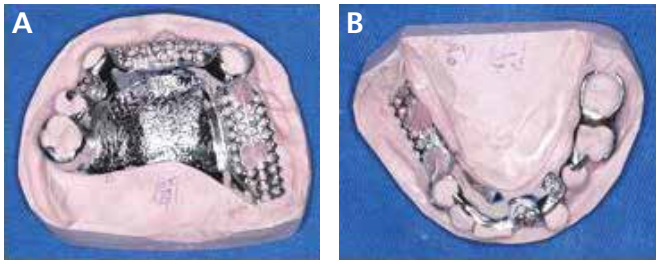

Figure 5. Maxillary and mandibular RPD frameworks.

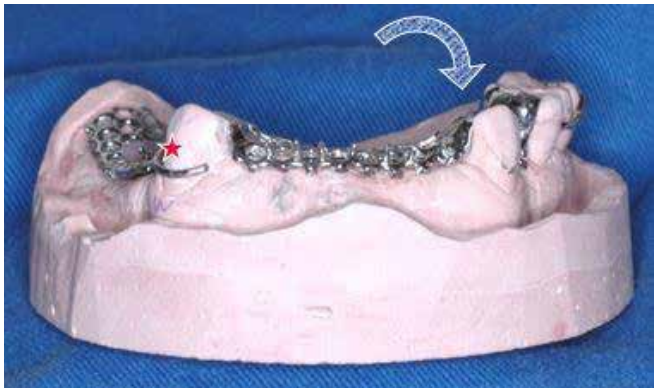

Figure 6. Maxillary: tooth 23 distobuccal undercut was engaged as the initial straight path. Then the remainder of the framework rotated to tooth 36 with the rotational center (star) on tooth 23 buccal cervical site.

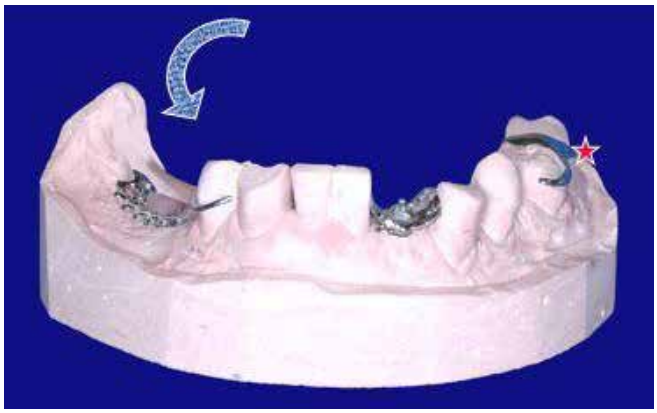

Figure 7. Mandibular: buccal clasp on tooth 37, rotational center (star), was placed first, then the remainder of the framework rotated to the direction of tooth 45.

Discussion

Rotational path removable partial dentures can be Classified in two different ways. For the first one, rotational path was divided into two categories that depend on the location of rotational centers. In category I, the rotational center is located at the terminal of extended rest. The rotational center is seated first, and the remainder of prosthesis seated into place. In category II, the rotational center is located at the gingival extension of the minor connector. The initial straight path of placement serves to

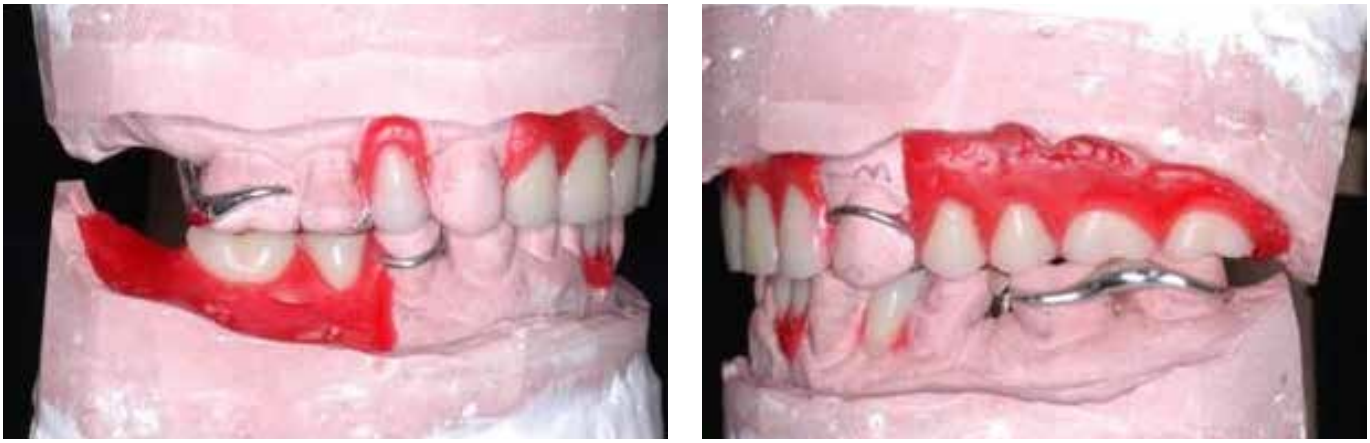

Figure 8. Maxillary and mandibular wax dentures.

Figure 9. Intra-oral view after partial denture in place.

seat the rotational center, followed by a curved path that allows the rests and remainder of the framework to be seated. This design is commonly used in replacement of missing anterior teeth.

For the second Classification, rotational path was divided into three types that depend on the sequence of denture seating. The first one is anterior-posterior sitting that the rotational path is from front to back, The second type is posterior-anterior sitting in which the rigid retainer on the posterior abutment sits first. The third one is lateral sitting in which the mesial and distal undercuts of the abutments on the either side of a unilateral edentulous space serve as a retention for its first segment and rotates toward the contralateral side[1].

In the case presented above, the rotational path of insertion for maxilla belongs to category II, lateral type. It was inserted from tooth 23 first, then rotate to tooth 16 with its rotational axis on the cervical area of tooth 23 buccal surface. In this case, for much better retention,

we used the rotational path removable partial denture design rather than the conventional removable partial denture design. In rotational path removable partial denture, the path of withdraw is not parallel to the potential path of dislodgement. And for the purpose of RPD stability, we reserved the tooth 23 buccal clasp for bracing effect. And also the clasp was located a less obvious position, which was at cervical third area of the tooth. The direction of rotational axis is perpendicular to the guiding plane of contralateral tooth, so if the remaining dentition of this case is tooth 15 rather than tooth 16, the undercut on tooth 23 should be engaged distally. This shows that the retention of tooth 23 buccal clasp is from the rigid portion of clasp root instead of flexible clasp tip.

The conventional treatment for this case is usually with tooth 23 surveyed crown, which accommodate a distal guiding plane, adequate mesiobuccal undercut and positive cingulum rest seat. The treatment options for undercut engaged are: (1) mesial I bar, (2)T bar or (3) wrought wire circumferential clasp. But the dislodging force from distal extension case is hard to resist by the above-mentioned treatment options, so the intimate and long distal guiding plane may be more effective than clasp. However, for the limitation of tooth length, contour and path of insertion, it is also unreliable to resist dislodging force by distal guiding plane. In application of a rotational path, the rigid portion of clasp engaged the undercut on tooth 23 distobuccal to distal area was much effective to resist dislodged force because distal or distobuccal undercut does not perpendicular to occlusal plane. On the other hand, use of wrought wire circumferential clasp has an advantage that is easy for further adjustment.

For the mandibular denture, the retentive undercuts available for conventional clasping of mandibular molars are usually located on their mesiolingual surface. Although it is acceptable for denture insertion by using lingual side undercut for retention, it is difficult for patients to remove the denture. So rotational path RPD is an applicable treatment option for this situation.

After surveying mandibular master cast, it was found that the undercut on tooth 36, 37 is on mesiobuccal side and the depth of undercut is not enough. In Kennedy Class II case, retentive clasp usually dislodged when occlusion on contralateral distal extension site. And reinforced the retention on retentive clasp is not an ideal method, because that might cause harm to abutment tooth or clasp loosening after a long-time wearing.

The rotational path of insertion for mandible belongs to category I, lateral type. It is notable that the undercut on fulcrum line will be engaged with proper force and undercut in front of fulcrum line will be stressed extensive pressure when distal extension was occluded, so the undercut in front of fulcrum line should be relieved and only the undercut on tooth 37 could be engaged.

The buccal clasp on tooth 37 was placed first and the remainder of the framework rotated to the direction of tooth 45. Finally, the minor connector engaged to undercut on tooth 37 mesiolingual surface, and meanwhile other rest seats and clasps completely located. The assemblies such as lingual plate and buccal clasps functions as bracing rather than retention. The conventional distal extension and rotational path concept should be taken into consideration while designing the buccal retentive clasp on tooth 45, so wrought wire circumferential clasp is a better choice than infrabulge retainer suggested by Ivanhoe[16].

The lingual surface of tooth 45 was blocked out (Fig.4D, 4E) with a specially designed block-out instrument according to designed rotational path of insertion. It is an important step to facilitate try-in of a framework of category I rotational path RPD, such as the situation of tilted mandibular molars.

Principally, conventional path of insertion is the first choice for designing removable partial denture. However, in some clinical cases, if conventional path is not suitable, rotational path design can be an alternative design option. Properly denture design and fabrication can conduce to successful and esthetic results to the patient.

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Case Report

Management of epulis fissuratum for maxillary complete denture fabrication - a case report

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Abstract

Mucosa lesions related to denture frequently occur. Epulis fissuratum is a tumor-like fibrous hyperplasia that arises due to irritation of poorly adapted denture. It can appear as a single or multiple folds located over the vestibular sulcus around the overextended border of denture. It is important to eliminate the irritation as it can also lead to malignant lesion such as carcinoma if ignored for a long time. The treatments include surgical removal of the lesion and provision of appropriate prosthetic reconstruction. This article presents a case that applied conventional surgical excision to remove epulis fissuratum followed by a new denture fabrication to achieve acceptable function and esthetics for patient.

Key words: Complete denture, Edentolous maxilla, Pre-prosthetic surgery

Introduction

Removable denture is used to restore the space previously occupied by teeth and their supporting structures that have been lost, and to rehabilitate function and esthetics. A well-fitted denture with maximum retention, stability and support is important to have a successful outcome. Wearing poorly fitted denture frequently results in mucosa lesions. Epulis fissuratum is one type of hyperplasia that develops in association with ill-fitted denture[1]. It is a benign tumor-like reactive lesion caused by chronic trauma of low intensity from overextension of denture border[2, 3]. The lesion appears with single or multiple folds of hyperplastic tissue and often with normal color and soft or firm consistency around the denture flange[2]. It is reported in 5-10% of denture wearers, and it occurred more commonly on the facial side of alveolar ridge and anterior vestibule in female population aged group between fifty and sixty[2, 4]. It also may cause carcinoma if ignored for a long time[2, 3]. Although elimination of irritation can decrease the size of lesion, surgical excision of the lesion and proper prosthetic restoration is the definitive treatment[5]. A case of epulis fissuratum with surgical excision before new denture fabrication is presented in this article.

Figure 1. Intra-oral view with old dentures. (a) upper ill-fitted complete denture. (b) lower removable partial denture.

Figure 2. Intra-oral view of upper edentulous ridge with extensive epulis fissuratum.

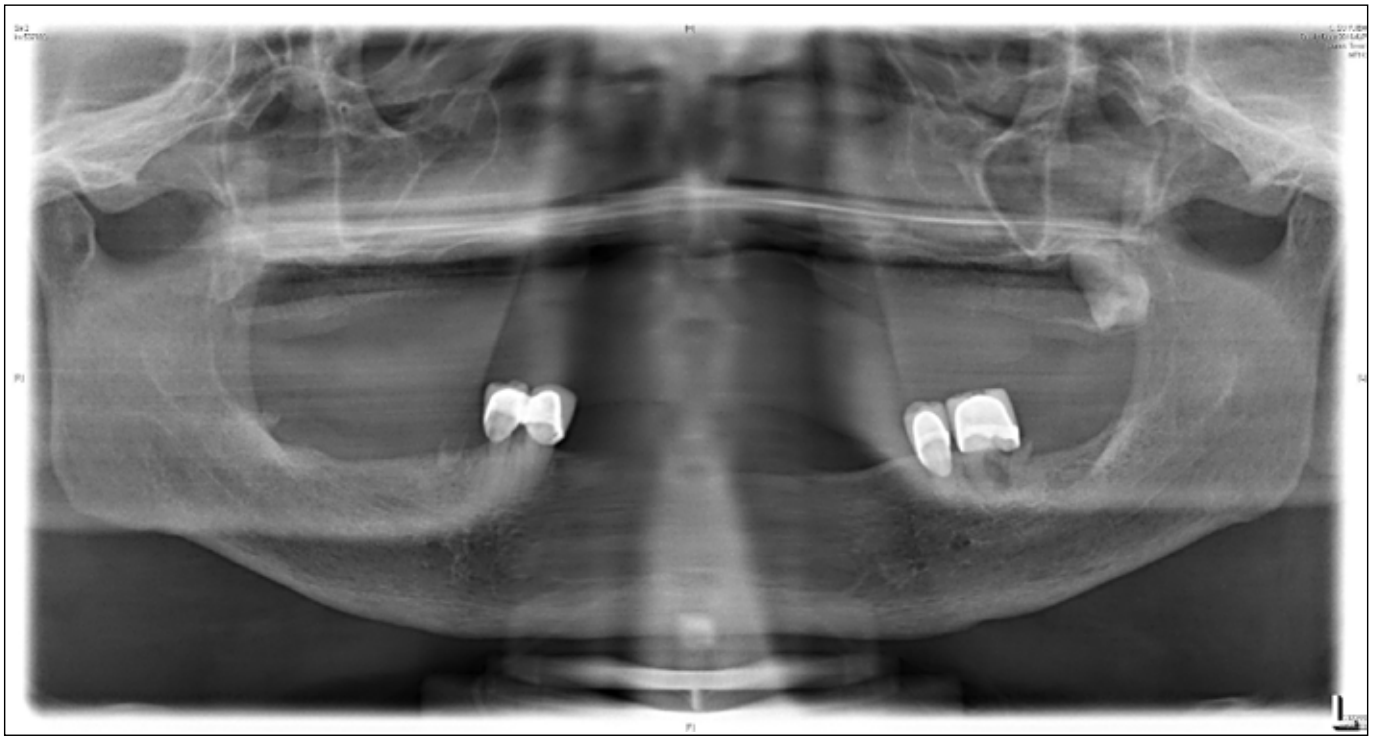

Figure 3. Panoramic film.

Case report

A 75-year-old female patient came to outpatient department with a complaint of broken maxillary denture and wanted to have a new maxillary denture made. She has worn the current maxillary complete denture and mandibular RPD for 10 years (Fig.1). Her medical history includes hypertension and diabetes mellitus that she reported to be under control. Intra-oral examination showed completely edentulous maxillary arch with severe flabby tissue over labial vestibule (Fig.2). Intra-oral examination in the mandibular arch showed with only four teeth remaining. Left mandibular second premolar and first molar were treated with single crowns. Right mandibular canine and first premolar were treated with splinted crowns. Panoramic film revealed an impacted maxillary left wisdom tooth embedded in bone, mandibular left first molar and right first premolar with abutment secondary caries at crown margin and residual root under mucosa over mandibular right second premolar and right wisdom tooth (Fig.3). The diagnosis of maxillary hard tissue were edentulism with only one left wisdom tooth which is bony impaction. The diagnosis of maxillary soft tissue was epulis fissuratum that involved left buccal and labial vestibule and right buccal vestibule. The diagnosis for mandible were missing of 31, 32, 33, 34, 37, 38, 41, 42, 46, 47, residual roots of mandibular right second premolar and wisdom tooth, abutment secondary caries at crown margin of mandibular left first molar and right first premolar.

Figure 4. Follow up of first surgery.

Figure 5. Secondary surgery : deepen the facial vestibule and remove muscle attachment.

Figure 6. Follow up of secondary surgery.

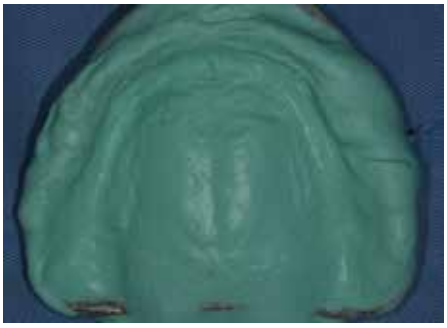

Figure 7. Primary impression.

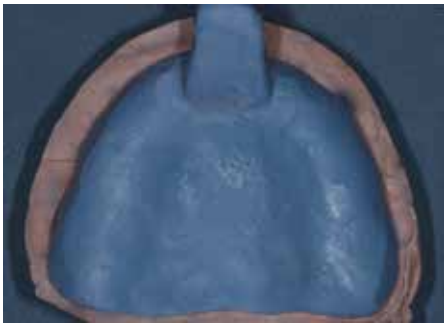

Figure 8. Custom tray fabrication.

Figure 9. Final impression.

The ideal treatment plan for maxilla was a new denture fabrication after surgical removal of the epulis fissuratum. Removal of ill-fitted crown and extraction of hopeless teeth and residual roots were needed before a new prosthesis fabrication for mandible. However, the patient chose to withhold mandibular treatment plan for financial consideration. The compromised treatment plan was to only treat the problems of maxilla: consult with the oral and maxillofacial (OMS) surgeon for epulis fissuratum excision, and new maxillary complete denture fabrication after surgery. The OMS surgeon advised of total excision of epilus fissuratum with peripheral mucosal repositioning and secondary epithelialization for preserving vestibule depth. The maxillary left wisdom was also in plan for extraction. The patient was instructed to stop denture wear. During wound healing, the flange of the old denture was shortened as an interim denture and advised to refrain from wearing unless necessary.

Surgical phase: The case was managed with conventional surgery excision targeting for a total excision of the extensive maxillary epulis fissuratum and the wound margins were sutured to the periosteum that has not been reflected for secondary epithelialization. The maxillary left wisdom tooth was extracted at the same time. The excised tissue was sent for histopathologic examination which showed squamous hyperplasia, fibrosis, and chronic inflammation, consistent with epulis fissuratum. Unexpectedly a nodule of 1mmx1mm recurred over left labial mucosa and loss of facial vestibular depth was found during follow-up (Fig.4). The second surgery was arranged to remove the recurred premaxilla epulis fissuratum and to deepen the facial vestibule by vestibuloplasty grafting with palatal graft (Fig.5). During the surgery, the buccal flange of the old denture was adjusted to avoid irritation as an interim prosthesis. The surgical wound healed properly and was in stable condition after one month (Fig.6). As a result, the patient was referred back to the prosthodontic department for a new maxillary denture fabrication.

Prosthetic management: Six weeks after surgery, primary impression for maxillary denture was made with irreversible hydrocolloid material (Fig.7), and the impression was poured with dental stone (Silky rock, Whip Mix, USA). One uniform thickness of dental wax (Paraffin wax, Sivuch, Taiwan) was placed over residual ridge and mid-palatal suture area as a spacer followed by custom tray fabrication (Fig.8). Selective impression technique was applied to relief pressure over these mentioned area.

Figure 10. Master cast.

Figure 11. Bite registration.

Figure 12. Upper denture delivery.

Maxillary arch border molding was made with polyether (Impregum Penta Soft, 3M ESPE, Germany) and the final impression was taken with polysulfide (Permlastic, Kerr, USA) (Fig.9), lastly the master cast was poured (ResinRock, Whip Mix, USA) (Fig.10). A record base and wax-rim was fabricated with average width and height. The maxillary incisal plane was adjusted intraorally using inter-pupillary line as reference. The vertical dimension of occlusion was determined with the freeway space, phonetics and esthetics. Centric relation record was taken (Fig.11) and the cast was mounted in a semi-adjustable articulator. The denture teeth were arranged to aim to provide stable cross arch balance within a functional range of eccentric movement. The maxillary complete denture was completed after wax denture try in (Fig.12). Laboratory remount was performed to correct the packing error. The occlusion was adjusted to achieve posterior teeth with even contact in centric relation and direct the force to central fossa of lower teeth. The ultimate aim was to achieve bilateral balanced occlusion, but patient refused to accept mandibular arch rehabilitation, therefore, maxillary denture teeth were adjusted to achieve occlusal stability in centric and unilateral group function in eccentric movement. The patient was suggested to adopt a diet with softer food and smaller food chunks, and to use both sides of posterior teeth when chewing without biting with front teeth. Denture care instruction was given to the patient including wearing the denture during the day, cleaning the denture after meal, and removing the denture before going to bed. The function and adaptation of upper denture were checked during follow-up, and the patient had neither discomfort nor complaint.

Discussion

Epulis fissuratum is also called inflammatory fibrous hyperplasia or denture-induced fibrous hyperplasia that is caused by low-intensity chronic irritation by ill-fitted denture. This proliferation may be the sequela of resorption of alveolar ridge, resulting from overextension of the denture borders causing chronic irritation to the mucosa in the sulcus area[6]. The size of epulis fissuratum varies from a small mass to involving the entire vestibule[6]. Although the lesion is usually painless, the patient can experience pain and discomfort[7]. A large lesion of epulis fissuratum can compromise denture retention and stability[7]. Histopathologic features are excessive bulk of fibrous connective tissue covered with stratified squamous epithelium[6]. In the early stage of epulis fissuratum, non-surgical treatment with denture adjustment and reline with tissue conditioner may be possible in decreasing the size of lesion. In the late stage, excision of epulis fissuratum is the optimal treatment of choice[8].

Varies surgical techniques can be chosen for the removal of epuplis fissuratum. Electrosurgery or laser technique is indicated for removing minimal enlarged lesion[8]. The excision with CO2 laser provides a few advantages including minimal postoperative pain and edema, hemostasis, no need for suture, and lesser loss of vestibule depth[9]. For extensive epulis fissuratum, just as our case, a conventional excision is the indicated choice[8].

To avoid loss of vestibule depth, three types of vestibuloplasty may be considered by surgeon: mucosa advancement vestibuloplasty, secondary epithlization vestibuloplasty and grafting vestibuloplasty. Secondary epithlization vestibuloplasty is an easy technique, therefore it was chosen for the first surgery. However,

it might have the disadvantage of rapid and unpredicted relapses that happened in our case. Grafting vestibuloplasty requires to sacrifice another donor site, however, the result of such vestibuloplasty is better by inhibiting the wound contraction and relapse[10]. Therefore, vestibuloplasty with grafting was chosen for the second surgery to correct the relapse in this case, better result was achieved.

The old denture relined with tissue conditioner can be used during wound healing, and denture impressions can be made after four weeks[8]. When fabricating the new denture, border molding and selective impression with custom tray were used to achieve maximum denture stress bearing within limiting area. Occlusion is adjusted to achieve optimum force distribution. Oral hygiene reinforcement was performed to facilitate long-term maintenance[8]. Regular follow-up was scheduled to check fitness and exact border extension for prevention of epulis fissuratum in the future.

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Journal of Prosthodontics and Implantology

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