A Comparison of the Subjective Masticatory Assessment Accompanied by Food Pictorial Illustration and Test-Chewing in Complete Denture Patients

Rattanauradinthra A[1] *Chainansamit T*[2] *Siriarpakul P*[3] *Yodsuwan D*[4] *Puasiri S*[5] *Paphangkorakit J*[6,*]

Research Article

Abstract

The correlation between subjective and objective masticatory assessment could be influenced by the recall ability of food items being asked. This study aimed to compare subjective masticatory assessments with food pictorial illustration and after chewing each food item (test-chewing), and to investigate the relationships between both subjective assessment methods and the objective masticatory assessment. The subjective masticatory assessment was conducted in 21 complete denture wearers using a questionnaire consisting of questions related to the chewing ability of 5 food items, first with food pictorial illustration and then after actually chewing the food. The objective masticatory assessment was performed using color-changeable chewing gum and scored on a 5-scale color shade. Paired t tests were used to determine difference between the subjective masticatory scores and Pearson correlations were used to test any existing correlations. The results showed that the agreement between subjective masticatory scores with pictorial illustration and with test-chewing was high (ICC=0.84). Both scores were not significantly different (20.1±3.9 vs 21.0±4.2 respectively). Neither scores were correlated with the objective masticatory score. It was concluded that subjective masticatory score using a questionnaire with pictorial illustration could reflect patients' actual perception on their chewing ability (likely to be obtained with test-chewing). Since test-chewing is not always practical in field research, using food questionnaire in conjunction with food pictorial illustration is recommended for the subjective assessment of masticatory function.

Key words: *Mastication/ Masticatory performance/ Subjective masticatory assessment*

Received: *Feb 06, 2024*
Revised: *Jun 06, 2024*
Accepted: *Jul 09, 2024*

Introduction

Tooth loss in the elderly leads to problems in chewing, aesthetics, speech, and psychological well-being, ultimately affecting their quality of life. Tooth loss is usually treated with fixed or removable prostheses. These dental prostheses substitute lost or extracted teeth and play a vital role in restoring jaw functions such as chewing, speech production, and facial aesthetics. Despite advanced dental substitution technology, complete dentures are still widely-prescribed for edentulous patients in various parts of the world. [1,2] Because of its tissue borne nature, a complete denture is less effective in breaking up food, compared to natural dentition.[3,4]

Various methods are used to assess masticatory function in patients with compromised dentition, broadly classified into subjective and objective assessments.[5] Objective assessment involved tests that can quantify the size distribution of chewed food particles[6,7] or the mixture of food colors during chewing. [8-10] The mixing ability test appears to be suitable for patients with complete dentures.[10] On the other hand, subjective assessments used questionnaires to evaluate

[1] *Department of Out Patient Dental Clinic, Faculty of Dentistry, Khon Kaen University, Khon Kaen.*
[2] *Dental Department, Khon Kaen Hospital, Amphur Mueang, Khon Kaen.*
[3] *Dental Department, Si Satchanalai Hospital, Amphur Si Satchanalai, Sukhothai.*
[4] *Department of Prosthodontics, Faculty of Dentistry, Khon Kaen University, Khon Kaen.*
[5] *Department of Preventive Dentistry, Faculty of Dentistry, Khon Kaen University, Khon Kaen.*
[6] *Department of Oral Biomedical Science, Faculty of Dentistry, Khon Kaen University, Khon Kaen.*
[*] *Corresponding Author*

chewing difficulty and/or chewing satisfaction.[11-14] Different studies have established their own lists of food items for the subjective assessment. Food questionnaires generally included a list of foods ranging from softest to hardest, with variations based on the geographical location of the population being studied. For example, Hirai et al.[11] utilized a questionnaire with a total of 35 food items, categorized into 5 groups, each containing 7 items, based on the texture and stickiness of the foods being Category I: pudding, bananas, boiled cabbage, boiled carrot, boiled taro, sliced raw tuna, boiled onions; Category II: strawberries, ham, boiled chicken, boiled fish paste patty, konnyaku, boiled kombu, raw cucumber; Category III: fried chicken, fried rice crackers, roast chicken, apples, pickled eggplants, boiled beef, raw cabbage; Category IV: roast pork, pickled scallion, pickled radish, rice cakes, peanuts, sliced raw cuttlefish, pork cutlet; Category V: raw carrots, takuwan, jellyfish, vinegared octopus, raw trepang, raw abalone, dried cuttlefish. Suwanarpa et al.[12] categorized 20 food items from Sato et al. into 5 grades according to increased chewing difficulty: Grade I: whole apple, chewing gum, dried shell ligament, dried cuttlefish; Grade II: fresh ear shell, hard pickled radish, hard cracker, hard biscuit; Grade III: pickled radish, peanuts, beef steak, rice-cake cubes; Grade IV: burdock, potato chips, boiled fish-paste (kamaboko), artificially-grown soybean; Grade V: boiled carrot, boiled potato, boiled eggplant, bean curd. In Thailand, Sakultae et al.[15] have also developed a food intake questionnaire, containing 20 local food items within 5 food categories according to their difficulty to chew and demonstrated that the score was correlated well with their overall chewing satisfaction in complete denture wearers.

Previous studies have shown mixed results in the relationship between subjective and objective assessments of masticatory function, with some reporting good correlation[11,12,16] whereas some reporting no correlation.[7,17-20] Such conflicting findings have limited the use of subjective assessment in research. The disagreement could be attributed to differences in individual's perception and recall ability when chewing difficulty was evaluated using questionnaires.

It was speculated that allowing participants to chew actual food (test-chewing) before answering the questionnaire would provide the most accurate evaluation of subjective masticatory assessment. However, the method seemed impractical in large-scale or community research. We therefore aimed to compare the result of subjective assessment with food pictorial illustration and that after actually chewing the food. Furthermore, the relationships between both subjective assessment methods and the objective assessment were investigated. The findings could contribute to the selection of methods for assessing subjective masticatory function.

Materials and Methods

This research was approved by the Center for Human Research Ethics at Khon Kaen University (HE642114). Twenty-one individuals, aged 61-90 years, comprising 16 males and 5 females, gave consent to participate in the study. The sample size was calculated based on a pilot study and deemed sufficient for the correlation analyses. Inclusion criteria were participants who have worn a complete denture for at least 6 months, having no allergic history to the test foods, no masticatory pain, mental disorders or cognitive impairments, oral diseases affecting chewing, and swallowing problems.

Determination of subjective masticatory function and test-chewing

A food questionnaire was developed for Thai elderly participants in the present study, based on the food categories with increasing hardness used in Hirai et al.[11] Five commonly consumed food items were selected including banana, fresh cucumber, apple, peanut, and raw mango. A 5-point Likert scale (1 for most problematic to 5 for no problem) was used to assess the perceived chewing ability of individual food items. The sum of scores obtained from all food items was defined as the 'subjective masticatory score'. In the first questioning session, a photo plate of the food items listed in the questionnaire was provided before answering the questionnaire (Figure 1). Subsequently, participants were

engaged in general conversation to create a distraction. Ten minutes after the first session, a session was conducted in which all participants were provided with actual food items listed in the questionnaire in a random order and asked to chew each of them ten times (test-chewing), spitting out before re-answering the question. To test the reliability of the questionnaire with pictorial illustration, a separate group of 7 similar participants re-answered the same questionnaire, one week apart. The Cronbach's alpha coefficient was found to be 0.83.

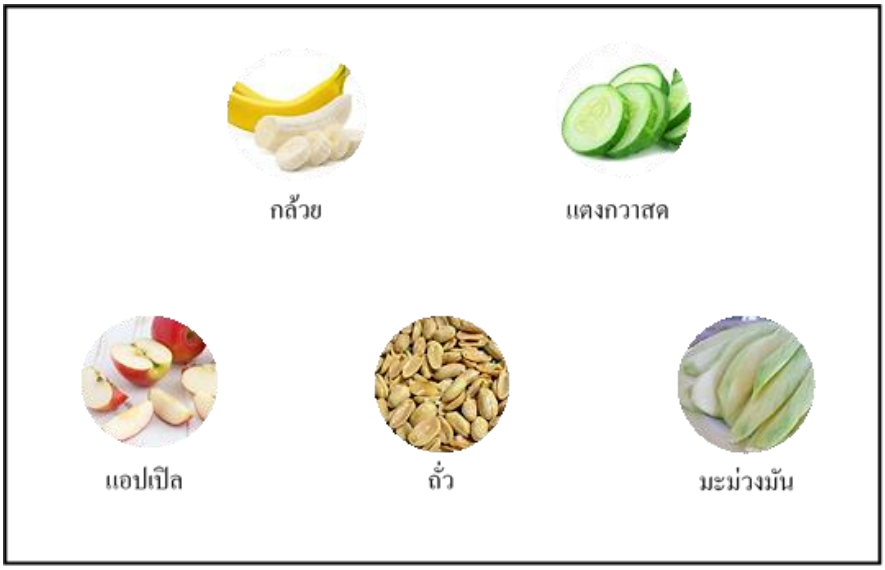


Figure 1 A photo plate used as food pictorial illustration in conjunction with the questionnaire during the subjective masticatory assessment

Determination of objective masticatory function

After completing the subjective masticatory assessment, the objective assessment was carried out in all participants using a color-changable chewing gum (Masticatory Performance Evaluating Gum XYLITOL, Lotte Co, Ltd, Tokyo, Japan). Participants were provided with a piece of color-changeable gum, measuring 70 x 20 x 1 mm, and were instructed to chew the gum habitually before spitting it out onto a piece of white paper. Two chewing gum trials were conducted, one for 60 cycles and another for 100 cycles, both of which have been recommended for the test.[21,22] The color of the chewed gum was evaluated using a color chart shown on the chewing gum's package, with scores ranging from 1 to 5 (according to the color shade from green to magenta; score 1 denoting the lowest performance and score 5 denoting the highest performance). The scores from both chewing gum tests were averaged and used as the 'objective masticatory score'.

Data Analysis

The subjective masticatory scores with food pictorial illustration and with test-chewing were compared using paired t tests whereas the scores of each food items were compared using Wilcoxon signed rank tests, due to different data distributions. The agreement between subjective scores with food pictorial illustrations and with test-chewing was also determined using intraclass correlation coefficients (ICC). Finally, the correlations between subjective and objective masticatory scores were tested using Pearson correlation.

Results

The participants consisted of 21 elderly complete denture wearers, with the majority being male (76.2%), aged between 60-69 years (47.6%), followed by those aged 70-79 years (42.9%), 80-89 years (14.3%) and 90 years (4.7%). The duration of current denture usage was predominantly within 1-5 years (52.4%).

Mean subjective masticatory scores obtained from the questionnaire with pictorial illustration and that with test-chewing were 20.1±3.9 and 21.0±4.2 respectively without significant difference (p=0.17; Table 1). No significant difference was also found when the scores from each food item were compared. The scores of both assessment methods were in high agreement (ICC=0.84). The mean objective masticatory score of the participants as assessed by the 5-color shade scale was 4.0±0.6. The objective masticatory score was not correlated with the subjective masticatory scores, either with food pictorial lustration or with test-chewing (Figure 2).

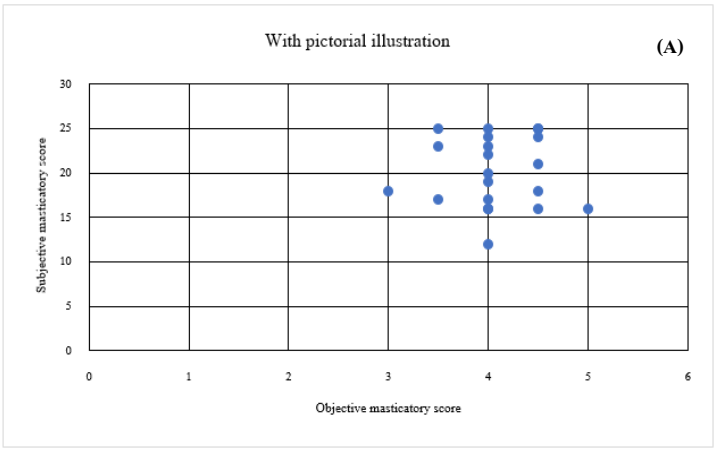
Table 1 Means and medians subjective masticatory scores of each individual food item obtained using a food questionnaire with food pictorial illustration and using the questionnaire with test-chewing (n=21)

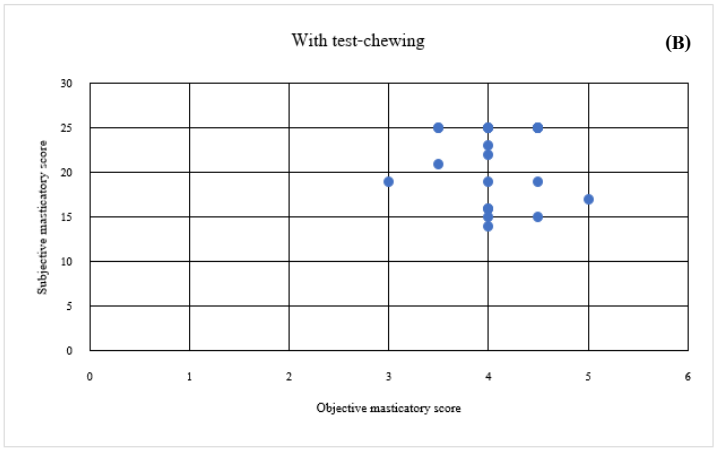
	With pictorial illustration		With test-chewing	
	Mean±SD	**Median (IQR)**	**Mean**±SD	**Median (IQR)**
Banana	5.0±0.0	5 (0)	5.0±0.0 ^{NS}	5 (0)
Fresh cucumber	4.3±0.9	5 (1)	4.3±0.9 ^{NS}	4 (1)
Apple	3.8±1.1	4 (2)	4.1±1.1 ^{NS}	5 (2)
Peanut	3.7±1.6	4 (2)	3.8±1.5 ^{NS}	5 (2)
Raw mango	3.3±1.5	3 (3)	3.8±1.3 ^{NS}	4 (2)
Total score	**20.1±3.9**		**21.0±4.2** ^{NS}	

SD = Standard deviation, IQR = Interquartile range

NS = Not significantly different at p=0.05

Figure 2 Scattered plots showing the insignificant relationship between the subjective masticatory score with food pictorial illustration (A), with test-chewing (B), and the objective masticatory score





Discussion

The present study has demonstrated that allowing participants to chew the food item listed in the questionnaire before answering did not differ in scores compared with answering the questionnaire in conjunction with pictorial illustration. Scores from both subjective assessments did not show any correlation with the objective masticatory score, consistent with findings from some previous studies.[7,17-20]

The insignificant difference of the subjective masticatory score obtained from both subjective methods indicated that participants had no recalling problems using the questionnaire with pictorial illustration. A high agreement was shown between the scores from subjective assessments with food pictorial illustration and with test-chewing. This could also be due to the fact that all food items were familiar to all participants. On the other hand, the 10-minute break between the first and second questioning sessions was relatively short, allowing participants to remember their answers. However, all participants were distracted during that period and not encouraged to duplicate the answers. It should be noted that most previous studies[7,15,17-20] did not use pictorial illustration in the subjective assessment. It would therefore be interesting to investigate in the future if there is any difference between answering the questionnaire with and without food pictorial illustration.

The correlation between both subjective assessments (either with pictorial illustration or with test-chewing) and objective masticatory assessment could not be demonstrated in the present study, consistent with findings from Boretti et al.[7] and Gunne et al.[18] but in contrast to those of Hirai et al.[11] and Suwanarpa et al.[12] It was, however, noted that the average subjective and objective masticatory scores of our participants were similar. Various factors could explain the insignificant correlation in the present study. While most food items were chosen from Hirai's study, our questionnaire only had one item in each food category. Thirty-five food items were used in Hirai's study whereas 20 food items were used in Suwanarpa's study, both demonstrating a significant correlation between subjective and objective assessment. This suggested that having more food items in each category might enhance the validity of the subjective masticatory score. Other factors could also influence the correlation. Hirai et al. and Suwanarpa et al. used a 3-level scoring system whereas a 5-level scoring system was employed in the present study, Boretti et al. and Gunne et al., suggesting that a simpler scoring method might be easier for the elderly to understand, resulting in a better correlation. Accordingly, using more food items with 3 simple scores might improve the correlation between both assessments. In addition, the type of food used in the objective assessment could influence the correlation between subjective and objective masticatory scores. Speksnijder et al. have shown that a silicone-based test food cannot effectively discriminate the masticatory performance in patients with compromised dentition, as opposed to wax which was easier to chew.[10] A hard test food like peanut and gummy jelly used in Hirai's and Suwanarpa's studies might be able to distinguish between extremely good and poor chewers but could not well discriminate those in between. The better discrimination using the chewing gum could make it more difficult to find the correlation. Overall, more than one factors could explain the inconsistent correlation between subjective and objective masticatory assessments. Using a different approach, Limpuangthip et al.[23] conducted a subjective assessment using OIDP (Oral Impact on Daily Performance) and demonstrated that the sensitivity and specificity of OIDP (item - oral impact on eating) in predicting masticatory performance was 74.2% and 92.2% respectively. The approach seemed to be advantageous since no food items were used in the OIDP questionnaire. It would be interesting to test the correlation between the OIDP score and objective masticatory assessment.

The present study was limited by the use of only five food items in the test-chewing session. It would be interesting to investigate the effect of test-chewing with a broader range of food items. Although there are currently no conclusive recommendations regarding the number of food items used in the food questionnaire, it is speculated that even with more food items, the agreement between questionnaires with pictorial illustration and test-chewing would still be

high, since food pictures help reduce the recall problem of the participants. Despite the aforementioned limitation, the present study has demonstrated that using a food questionnaire together with food pictorial illustration in masticatory research or clinical practice can reflect the actual subjective masticatory function. Presumably, this type of questionnaire improves the accuracy of the assessment by reducing interindividual variations in recalling each food item. In order to further verify the validity of the 5-food item questionnaire used in the present study, it is necessary to test its ability in differentiating patients with different levels of compromised dentition. In addition, including more food items in the test-chewing session could further provide information on the accuracy of pictorial illustration of each specific food and will be useful in the future development of the questionnaire.

Conclusion

The present study has shown that the questionnaire with pictorial illustration can reflect actual subjective assessment of masticatory function. In addition, test-chewing did not appear to improve the correlation between subjective and objective masticatory assessment as hypothesized.

References

1. Gil-Montoya JA, de Mello AL, Barrios R, Gonzalez-Moles MA, Bravo M. Oral health in the elderly patient and its impact on general well-being: a nonsystematic review. Clin Interv Aging 2015;10:461-7.
2. Hirotomi T, Yoshihara A, Yano M, Ando Y, Miyazaki H. Longitudinal study on periodontal conditions in healthy elderly people in Japan. Community Dent Oral Epidemiol 2002;30(6):409-17.
3. Helkimo E, Carlsson GE, Helkimo M. Bite force and state of dentition. Acta Odontol Scand 1977;35(6):297-303.
4. Manzon L, Vozza I, Poli O. Bite force in elderly with full natural dentition and different rehabilitation prosthesis. Int J Environ Res Public Health 2021;18(4):1424.
5. Elgestad Stjernfeldt P, Sjögren P, Wårdh I, Boström AM. Systematic review of measurement properties of methods for objectively assessing masticatory performance. Clin Exp Dent Res 2019;5(1):76-104
6. Fueki K, Yoshida E, Igarashi Y. A structural equation model relating objective and subjective masticatory function and oral health-related quality of life in patients with removable partial dentures. J Oral Rehabil 2011;38(2):86-94.
7. Boretti G, Bickel M, Geering AH. A review of masticatory ability and efficiency. J Prosthet Dent 1995;74(4):400-3.
8. Müller F, Hernandez M, Grütter L, Aracil-Kessler L, Weingart D, Schimmel M. Masseter muscle thickness, chewing efficiency and bite force in edentulous patients with fixed and removable implant-supported prostheses: a cross-sectional multicenter study. Clin Oral Implants Res 2012;23(2):144-150.
9. Schimmel M, Memedi K, Parga T, Katsoulis J, Müller F. Masticatory performance and maximum bite and lip force depend on the type of prosthesis. Int J Prosthodont 2017;30(6):565–572.
10. Speksnijder CM, Abbink JH, van der Glas HW, Janssen NG, van der Bilt A. Mixing ability test compared with a comminution test in persons with normal and compromised masticatory performance. Eur J Oral Sci 2009;117(5):580-6.
11. Hirai T, Ishijima T, Koshino H, Anzai T. Age-related change of masticatory function in complete denture wearers: evaluation by a sieving method with peanuts and a food intake questionnaire method. Int J Prosthodont 1994;7(5):454-60.
12. Suwanarpa K, Hasegawa Y, Salazar S, Kikuchi S, Yoshimoto T, Paphangkorakit J, et al. Can masticatory performance be predicted by using food acceptance questionnaire in elderly patients with removable dentures? J Oral Rehabil 2021;48(5):582–91.
13. Sato Y, Minagi S, Akagawa Y, Nagasawa T. An evaluation of chewing function of complete denture wearers. J Prosthet Dent 1989;62(1):50-3.

14. Peršić S, Palac A, Bunjevac T, Celebić A. Development of a new chewing function questionnaire for assessment of a self-perceived chewing function. Community Dent Oral Epidemiol 2013;41(6):565-73.
15. Sakultae C, Tumrasvin W, Limpuangthip N. Development of food intake questionnaire for evaluating masticatory ability of complete denture wearers. Khon Kaen Dent J 2021;24(2):49-60.
16. Demers M, Bourdages J, Brodeur JM, Benigeri M. Indicators of masticatory performance among elderly complete denture wearers. J Prosthet Dent 1996; 75(2):188-93.
17. Leake JL. An index of chewing ability. J Public Health Dent 1990;50(4):262-7.
18. Gunne HS, Bergman B, Enbom L, Högström J. Masticatory efficiency of complete denture patients. A clinical examination of potential changes at the transition from old to new denture. Acta Odontol Scand 1982;40(5):289-97.
19. Pedroni-Pereira A, Marquezin MCS, Araujo DS, Pereira LJ, Bommarito S, Castelo PM. Lack of agreement between objective and subjective measures in the evaluation of masticatory function: A preliminary study. Physiol Behav 2018;184:220-25.
20. Slagter AP, Olthoff LW, Bosman F, Steen WH. Masticatory ability, denture quality, and oral conditions in edentulous subjects. J Prosthet Dent 1992;68(2): 299-307.
21. Komagamine Y, Kanazawa M, Minakuchi S, Uchida T, Sasaki Y. Association between masticatory performance using a colour-changeable chewing gum and jaw movement. J Oral Rehabil 2011;38(8):555-63.
22. Ishikawa Y, Watanabe I, Hayakawa I, Minakuchi S, Uchida T. Evaluations of masticatory performance of complete denture wearers using color-changeable chewing gum and other evaluating methods. J Med Dent Sci 2007;54(1):65-70.
23. Limpuangthip N, Somkotra T, Arksornnukit M. Subjective and objective measures for evaluating masticatory ability and associating factors of complete denture wearers: A clinical study. J Prosthet Dent 2021;125(2):287-93.

Corresponding Author

Jarin Paphangkorakit
Department of Oral Biomedical Science,
Faculty of Dentistry, Khon Kaen University,
Amphur Mueang, Khon Kaen, 40002.
Tel. : +66 43 202 405 #45281
Fax : +66 43 202 862
E-mail : jarin@kku.ac.th

การเปรียบเทียบผลการประเมินการบดเคี้ยวแบบจิตวิสัยแบบมีภาพประกอบและแบบให้ทดลองเคี้ยวในผู้ป่วยใส่ฟันเทียมทั้งปาก

อรรจิร์นุช รัตนอุรดินทร์ [1] ธนิภา ชัยนันท์สมิตย์ [2] ปริษา ศิริอาภากุล [3] คนัย ยอดสุวรรณ [4] สุบิน พัวศิริ [5] จรินทร์ ปภังกรกิจ [6,]*

บทความวิจัย

บทคัดย่อ

ความสามารถในการจดจำอาหารประเภทต่างๆ ในการประเมินการบดเคี้ยวแบบจิตวิสัยอาจเป็นปัจจัยหนึ่งที่ส่งผลต่อความสัมพันธ์การประเมินการบดเคี้ยวแบบจิตวิสัยและวัตถุวิสัย การศึกษานี้มีวัตถุประสงค์เพื่อเปรียบเทียบผลการประเมินการบดเคี้ยวแบบจิตวิสัยแบบมีภาพประกอบของอาหารกับแบบที่ให้ทดลองเคี้ยวจริงก่อนตอบแบบสอบถาม และหาความสัมพันธ์ระหว่างการประเมินทั้งสองแบบกับการประเมินการบดเคี้ยวแบบวัตถุวิสัย โดยทำการประเมินการบดเคี้ยวแบบจิตวิสัยในผู้ป่วยที่ใส่ฟันเทียมทั้งปากจำนวน 21 คน ด้วยแบบสอบถามความสามารถในการบดเคี้ยวที่มีภาพประกอบอาหาร 5 ชนิด และแบบสอบถามภายหลังให้อาสาสมัครทดลองเคี้ยวจริง จากนั้นทำการประเมินการบดเคี้ยวแบบวัตถุวิสัย ด้วยการเคี้ยวหมากฝรั่งที่เปลี่ยนสีได้ โดยใช้เทียบสีกับมาตรสี 5 ระดับ วิเคราะห์ความแตกต่างของข้อมูลด้วยการทดสอบทีแบบจับคู่ และวิเคราะห์ความสัมพันธ์ด้วยสหสัมพันธ์เพียร์สัน ผลการศึกษาพบว่าการประเมินการบดเคี้ยวแบบจิตวิสัยโดยมีภาพประกอบกับแบบให้ทดลองเคี้ยว มีความสอดคล้องกันในระดับสูง (ICC=0.84) และมีค่าคะแนนแตกต่างกันอย่างไม่มีนัยสำคัญทางสถิติ (20.1±3.9 และ 21.0±4.2 ตามลำดับ) อย่างไรก็ตามการประเมินการบดเคี้ยวแบบจิตวิสัยทั้งสองแบบไม่มีความสัมพันธ์กับคะแนนประเมินการบดเคี้ยวแบบวัตถุวิสัย สรุปว่า การประเมินการบดเคี้ยวแบบจิตวิสัยโดยมีภาพประกอบสามารถสะท้อนการรับรู้ในการเคี้ยวอาหารที่แท้จริงของผู้ป่วย (ซึ่งน่าจะเกิดจากได้ทดลองเคี้ยว) และเนื่องจากการให้ทดลองเคี้ยวอาจไม่สามารถกระทำได้ในงานวิจัยภาคสนาม การใช้แบบสอบถามที่มีภาพประกอบของอาหารจึงเป็นวิธีที่แนะนำในการประเมินการบดเคี้ยวแบบจิตวิสัย

คำไขรหัส: *การบดเคี้ยว/ สมรรถนะการบดเคี้ยว/ การประเมินการบดเคี้ยวแบบจิตวิสัย*

ผู้ประพันธ์บรรณกิจ

จรินทร์ ปภังกรกิจ
สาขาวิชาชีวเวชศาสตร์ช่องปาก
คณะทันตแพทยศาสตร์ มหาวิทยาลัยขอนแก่น
อำเภอเมือง จังหวัดขอนแก่น 40002
โทรศัพท์: 043 202 405 #45281
โทรสาร: 043 202 862
จดหมายอิเล็กทรอนิกส์: jarin@kku.ac.th

[1] หน่วยทันตกรรมผู้ป่วยนอกและบำบัดฉุกเฉิน โรงพยาบาลทันตกรรม คณะทันตแพทยศาสตร์ มหาวิทยาลัยขอนแก่น จังหวัดขอนแก่น
[2] แผนกทันตกรรม โรงพยาบาลขอนแก่น อำเภอเมือง จังหวัดขอนแก่น
[3] แผนกทันตกรรม โรงพยาบาลศรีสัชนาลัย อำเภอศรีสัชนาลัย จังหวัดสุโขทัย
[4] สาขาวิชาทันตกรรมประดิษฐ์ คณะทันตแพทยศาสตร์ มหาวิทยาลัยขอนแก่น จังหวัดขอนแก่น
[5] สาขาวิชาทันตกรรมป้องกัน คณะทันตแพทยศาสตร์ มหาวิทยาลัยขอนแก่น จังหวัดขอนแก่น
[6] สาขาวิชาชีวเวชศาสตร์ช่องปาก คณะทันตแพทยศาสตร์ มหาวิทยาลัยขอนแก่น จังหวัดขอนแก่น
[*] ผู้ประพันธ์บรรณกิจ