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Original article

Relationship between masticatory performance using a gummy jelly and masticatory movement

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ABSTRACT

Purpose: The purpose of this study was to clarify the relationship between masticatory performance using a gummy jelly and masticatory movement.
Methods: Thirty healthy males were asked to chew a gummy jelly on their habitual chewing side for 20s, and the parameters of masticatory performance and masticatory movement were calculated as follows. For evaluating the masticatory performance, the amount of glucose extraction during chewing of a gummy jelly was measured. For evaluating the masticatory movement, the movement of the mandibular incisal point was recorded using the MKG K6-I, and ten parameters of the movement path (opening distance and masticatory width), movement rhythm (opening time, closing time, occluding time, and cycle time), stability of movement (stability of path and stability of rhythm), and movement velocity (opening maximum velocity and closing maximum velocity) were calculated from 10 cycles of chewing beginning with the fifth cycle. The relationship between the amount of glucose extraction and parameters representing masticatory movement was investigated and then stepwise multiple linear regression analysis was performed.
Results: The amount of glucose extraction was associated with 7 parameters representing the masticatory movement. Stepwise multiple linear regression analysis showed that the opening distance, closing time, stability of rhythm, and closing maximum velocity were the most important factors affecting the glucose extraction.
Conclusion: From these results it was suggested that there was a close relation between masticatory performance and masticatory movement, and that the masticatory performance could be increased by rhythmic, rapid and stable mastication with a large opening distance.

1. Introduction

Clinical practice of dentistry is primarily aimed at restoring and maintaining the masticatory function. In general, masticatory function is evaluated by analyses of the occlusal force, masticatory performance, masseter muscular activity, masticatory movement, etc. [1–10].

Masticatory performance is an important parameters for objective evaluation of the masticatory function. For many years, the masticatory performance has been measured by the sieving method [11], in which the subject chews a test food for a

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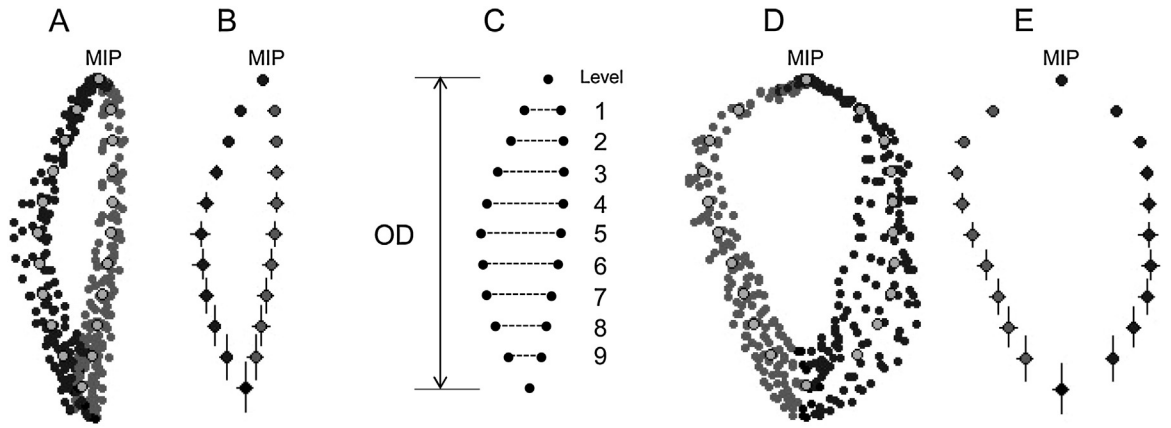

Fig. 1 – Method used to calculate average path, standard deviation (SD), opening distance (OD), masticatory width, and velocity (example of the subject 1).
(A) Overlapping of each cycle and average path as viewed from the frontal plane. MIP: maximum intercuspal position. (B) Average path and SDs of each level as viewed from the frontal plane. (C) OD and masticatory width from the first to the ninth level. (D) Overlapping of each cycle and average path as viewed from the velocity component. (E) Average path and SDs of each level as viewed from the velocity component.

specific number of times, and the crushed test food is collected from the oral cavity and divided by sieving according to the degree of crushing. This method, however, is beset with problems related to the complex manipulations needed and the long time taken for the test. Recently, simpler methods using silicon impression material [12,13], chewing gum [6,14], paraffin wax [5,15] or gummy jelly [16–19] as the test foods have been attempted. Of these methods, measurement of the glucose extraction during chewing of gummy jelly has attracted close attention, because of the simple manipulations needed, easy control of hygiene, possibility of standardization of the physical and other properties of the gummy jelly as the test food, and reports of a positive correlation between the masticatory performance as measured by this method and that measured by the sieving method [18].

On the other hand, investigation of the masticatory movement also seems to be useful for quantitative and objective evaluation of the masticatory function. Based on this view, many attempts have been made to analyze the amount, rhythm, velocity, stability, etc., of masticatory movement [5,6,9,10,20–24]. Masticatory movement is known to be affected by the masticatory condition, e.g., exogenous factors such as the test food, the chewing method, and the range of analysis, and can vary even among healthy subjects. Thus, it has been pointed out that when masticatory movements are evaluated, the variations arising from these factors need to be minimized [3,4]. In regard to comparison of the masticatory performance and quantitative parameters of masticatory movement between males and females, while some studies [19,25] have reported the absence of any gender-related differences, others have reported higher masticatory performance, a larger amount of movement and shorter cycle time in males than in females; [16,20–22] these finding suggest that while evaluating masticatory function, attention must also be paid to possible gender-related differences [9].

Previous studies have reported on the correlations between the masticatory performance and parameters of masticatory movement [1,2,5,6,10]. However, the parameters of masticatory movement varied from study to study, and no consensus had been reached. One possible reason for this is the fact that the masticatory movement is affected by the masticatory condition [26–28], such as the test food, the chewing method and the range of analysis. In addition, an influence of gender is also likely.

In order to clarify the relationship between masticatory performance using a gummy jelly and masticatory movement, we analyzed the amount of glucose extraction, the movement path, the movement rhythm, the stability of movement, and the movement velocity, while paying close attention to the masticatory condition, in healthy male subjects.

Out of many parameters that represent masticatory movement, to clarify the parameters that affect masticatory performance is an attempt to make it possible to infer masticatory performance from masticatory movement, and has clinical values to it.

2. Materials and methods

2.1. *Ethics statement*

This study was carried out with the approval of the Ethics Committee of Nippon Dental University School of Life Dentistry (NDU-T2012-29). Informed consent after explanation about the study design was collected from each subject prior to their participation in the study.

2.2. *Subjects*

Thirty healthy male subjects (age 21–36 years; mean age 27.4 years) participated in this study. All the subjects satisfied all of the following inclusion criteria: (1) had no evident abnormalities in the body or in the mastication system, (2) could identify the habitual chewing side, (3) had natural

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