Characterization of Masticatory Function in Patients with Myotonic Dystrophy. Part 1: Correlations among the Factors of Masticatory Function

George Umemo, DDS,a Yoshihiro Tsukiyama, DDS, PhD,b Hirokazu Nakamura, DDS, PhD,c and Kiyoshi Koyano, DDS, PhDb

a Department of Dentistry and Oral Surgery, School of Medicine, Fukuoka University, Fukuoka, Japan
b Department of Removable Prosthodontics, Faculty of Dental Science, Kyushu University, Fukuoka, Japan
c Dental Branch, National Center of Neurology and Psychiatry, Musashi Hospital, Tokyo, Japan

Clinical significance
This study was conducted to characterize masticatory function in patients with myotonic dystrophy, and the results provide a clear impression of masticatory disturbances in patients with myotonic dystrophy.

Abstract
Purpose: The purpose of this study was to characterize masticatory function in patients with myotonic dystrophy (MyD) and to clarify the masticatory disturbances that might be encountered in these patients.

Methods: Eighteen patients with MyD with an average age of 54.1 years were enrolled as the subjects of this study. Factors such as activities of daily living (ADL), occlusal contact area, number of foods that were easy to chew, maximum bite force, and muscle activity in the temporal and masseter muscles during one chewing cycle were investigated, and the correlations among these factors were evaluated in these patients.

Results: The ADL score was significantly correlated with only the occlusal contact area. A significant negative correlation was observed between the muscle activity in the temporal and masseter muscles and the maximum bite force (P < 0.05), as well as between the muscle activity and the number of foods that were easy to chew (P < 0.01). A significant positive correlation was observed between the maximum bite force and the number of foods that were easy to chew (P < 0.01), as well as between the maximum bite force and the occlusal contact area (P < 0.01).

Conclusion: These results suggest that patients with MyD find only a few types of foods easy to chew because of their weak bite force, and that they compensate for the weak bite force by greatly increasing their temporal and masseter muscle activity while chewing. Also, patients with MyD with a low ADL score frequently have a small occlusal contact area.

Key words: myotonic dystrophy, masticatory function, muscle activity, bite force, food easy to chew

Introduction
Myotonic dystrophy (MyD) is a myopathy of autosomal dominant inheritance, which is characterized by muscle atrophy, myotonia and multisystem disease. The disease is characterized by some aspects of presenility, such as dementia, cataract, diabetes, hyperlipidemia, arteriosclerosis, and a high incidence of malignant tumors, and should be managed from a geriatric medical viewpoint. Some reports have indicated a high incidence of dental problems, aberrations of craniofacial morphology, malocclusion, malalignment, reduced masticatory muscle function, dysmastic, dysphagia, poor oral hygiene, caries, periodontitis, and dislocation of the temporomandibular joint in cases of MyD. Although swallowing problems in these patients have drawn attention from the standpoint of the risk of aspiration pneumonia, very few studies have investigated masticatory function and the characteristic masticatory disturbances that might be encountered in these patients. In this study, masticatory function was examined in 18 patients with MyD with the purpose of clarifying the characteristic masticatory disturbances in these patients.
Materials and methods

Subjects
Eighteen patients (consisting of eleven men and seven women) with MyD seen at the Department of Neurology, National Center of Neurology and Psychiatry, Musashi Hospital, between January 1999 and December 2002, with an average age of 54.1 years (SD, 4.7) were enrolled for the study. The patients were informed about the risks involved in the examinations, and also clearly explained that the study could be stopped at any time if they so desired. Informed consent was obtained from all of the patients prior to their participation.

Activities of daily living (ADL)
Activities of daily living (ADL) was assessed based on the scores in the following 8 functional domains: walking, standing up, sitting down, putting on clothes, evacuating, bathing, washing of the face, and rinsing of the mouth. Each item was scored on a 0–1 scale, with lower scores indicating greater functional impairment: 0=totally dependent; 0.5=needs assistance; 1=independent. The total ADL disability score was obtained by summing the scores for all the above items. This method of assessing the ADL was based on the self-reported ADL scale proposed by Ahlström et al. with some modification.

Occlusal contact area
The occlusal contact area was recorded using the Dental Prescale System (Fuji Film, Tokyo, Japan). Each subject was instructed to bite a Dental Prescale sheet as hard as possible for 3 seconds, and the test was repeated three times. The occlusal contact area was estimated by scanning the test sheet, and the average result of the test conducted in triplicate was obtained.

Number of foods that are easy to chew
A questionnaire (Sato, 1989) survey of the patients was conducted to determine the ease with which the patients could chew the 20 types of food items listed in the questionnaire, and the number of foods that could be chewed easily was determined. The answer options to determine the chewability of the listed food items were “easy to chew,” “difficult to chew,” and “impossible to chew”

Maximum bite force
The maximum bite force on each side was recorded from the right and left front molar regions using the Occlusal Force Meter GM10 (Nagano Keiki, Japan). Data were acquired in triplicate from each region and the average was determined. A significant positive correlation was observed between the maximum bite force measured using the Occlusal Force Meter GM10 and the occlusal contact area measured using the Dental Prescale System ($r = 0.511, P<0.05$).

Muscle activity
Muscle activity in the temporal and masseter muscles during one cycle of chewing was measured using the K6I measuring system (Myotronics Inc. Seattle, USA, Schindler 1998). The electrical activities in the masseter and temporal muscles were recorded using bipolar surface electrodes. Jaw movements at the incisal point and electromyographic signals were recorded simultaneously with the chewing movements. The subjects were asked to chew a cotton roll that could not be aspirated, unlike food. The chewing movements were recorded over a period of approximately 15 seconds, and the data obtained for 5 chewing strokes, i.e., from the sixth to the tenth strokes, were analyzed. The electrical activity from each individual stroke was converted into the percent electrical activity attained during maximum voluntary clenching (MVC%).

Data analysis
Pearson’s correlations or Spearman’s correlations were calculated to determine the relationships among the factors examined, i.e., the ADL, occlusal contact area, number of foods that were easy to chew, activities in the temporal and masseter muscles, and the maximum bite force.

All statistical analyses were performed using SPSS 13.0 J for Windows.

Results
Activities of daily living (ADL)
Of all the patients with MyD, 89% could rinse their mouth by themselves; on the other hand, only 58% could stand up and 38% could walk without assistance (Fig. 1).

Occlusal contact area
The average occlusal contact area in the patients
was 6.7 mm² (SD, 5.7), and 44% of the patients had an anterior open bite.

Number of foods that are easy to chew
The average number of foods that were easy to chew was 13.9 (SD, 2.5). All of the MyD patients had selected the “easy to chew” option for boiled carrots and potatoes, but only 50% selected this option for hard crackers and 25% selected it for a whole apple (Fig. 2).

Maximum bite force and chewing
The average value of the maximum bite force was 71.8 N (SD, 36.4). The average muscle activity in the temporal and masseter muscles during one chewing cycle was 40.0% (SD, 19.1) (MVC%). The average range of jaw opening during chewing was 10.8 mm (SD, 4.7), and the average chewing stroke duration was 0.78 second (SD, 0.05).

Correlations among the factors examined
The ADL score was significantly correlated with only the occlusal contact area (Table 1). A significant negative correlation was observed between the muscle activity in the temporal and masseter muscles and the maximum bite force ($P<0.05$) (Fig. 3), with a correlation coefficient of $-0.603$. A significant positive correlation was observed between the maximum bite force and the number of foods that were easy to chew ($P<0.01$) (Fig. 4), with a correlation coefficient of 0.674. A significant negative correlation was observed between the muscle activity and the number of foods that were easy to chew ($P<0.01$) (Fig. 5), with a correlation coefficient of $-0.744$. A significant positive correlation was observed between the maximum bite force and the occlusal contact area ($P<0.01$) (Fig. 6), with a correlation coefficient of
muscle activity in the temporal and masseter muscles and the bite force is of utmost importance in the investigation of masticatory function in MyD. The K6I measuring system for muscle activity and the Occlusal Force Meter GM10 for measuring the bite forces are considered to be adequately suited for assessing the masticatory function in patients with MyD.

Bakke et al.\(^{12}\) showed in a 19-year-old man with MyD that while the strength of the mandibular elevator muscle and the bite force were less than one-third of the normal, the relative strength of contraction (closing strength in terms of the MVC\(\%\)) was increased during natural and un instructed chewing of an apple. This is in agreement with our finding of a negative correlation between the temporal and masseter muscle activities and the maximum bite force.

There are no reports of evaluation of masticatory function by assessing the number of foods that are easy to chew in cases of MyD. The present results indicate a positive correlation between the maximum bite force and the number of foods that were easy to chew, but a negative correlation between the muscle activity in the temporal and masseter muscles and the number of foods that are easy to chew, muscle activity, and maximum bite force.

**Discussion**

Esophageal symptoms were already mentioned in the initial descriptions of MyD by Steinert in 1909, and several reports since have evaluated pharyngoesophageal motor involvement in cases of MyD.\(^{4,9}\) Many complaints related to the posterior phase of swallowing, such as choking, are reported by patients with MyD.\(^{10}\) From the dental point of view, however, it is also doubtful whether foods are chewed well enough in the anterior phase of deglutition. Malocclusion, reduced masticatory muscle function and reduced bite force have been reported in MyD patients;\(^{11}\) however, few studies have evaluated these functions objectively.

The results of a preliminary investigation conducted by us revealed that evaluation of the muscle activity in the temporal and masseter muscles and the bite force is of utmost importance in the investigation of masticatory function in MyD. The K6I measuring system for muscle activity and the Occlusal Force Meter GM10 for measuring the bite forces are considered to be adequately suited for assessing the masticatory function in patients with MyD.

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**Table 1** Relationships among the factors examined in this study: ADL, occlusal contact area, number of foods that are easy to chew, muscle activity, and maximum bite force.

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N.S.: Not significant, *: \(P<0.05\), **: \(P<0.01\)
foods that were easy to chew. Namely, patients with a weak bite force, found few foods easy to chew and chewed with great muscle activity, and some were not able to chew a whole apple no matter how hard they chewed. Some patients reported that they could easily chew all types of foods, however this might only reflect their uncomplaining nature.

On the other hand, the ADL score significantly correlated with only the occlusal contact area. Great individual variations in symptoms, a characteristic feature of MyD, might explain the absence of significant correlation between the ADL score and the other factors known to influence masticatory function. Although patients with MyD have been demonstrated to have lower EMG activity in the masticatory muscles great individual variations in the severity of involvement of the masticatory muscles were pointed out by Ödman et al. Some patients do not show any remarkable muscle atrophy or muscle weakness, therefore, the absence of any correlation between the ADL score and the other factors known to influence masticatory function might also be a feature of MyD.

Conclusion

These results suggest that patients with MyD find few foods easy to chew because of their weak bite force, and compensate for this weakness by greatly increasing their masticatory muscle activity chewing. Also, patients of MyD with poor ADL frequently have a small occlusal contact area.

Acknowledgments: This study was supported by the Department of Neurology at the National Center of Neurology and Psychiatry, Musashi Hospital.

References