

Effect of the Mandibular Orthopedic Repositioning Appliance (MORA) on Forearm Muscle Activation and Grasping Power during Pinch and Hook Grip

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Abstract. [Purpose] This study verified the changes in muscle activities and grasping power during maximal isometric exercise of the forearm and masseter muscle with and without a mandibular orthopedic repositioning appliance (MORA). It also offers basic data for defining the correlation of function of hand with mouth. [Methods] EMG was used to measure masticatory muscle, flexor bundle and extensor bundle activities with or without MORA while subjects performed the hook grip and pinch grip. The measuring tool used for measuring grip strength was the same as that used for measuring pinch and hook strength. The subjects were 28 healthy young adults. [Result] Muscle activity and grasping power significantly increased when wearing the MORA. [Conclusion] The result indicates that wearing MORA can increase muscle activity and grasping power of forearm and masseter muscle. We think wearing MORA might help improve the function of the forearm because it activates the function of the masseter.

Key words: MORA, Muscle activation, Grip power

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INTRODUCTION

The area controlling the movements of the hand is wide in the motor homunculus corresponding to the body in the cerebral cortex. The mouth area, located next to the hand area in the motor homunculus, is also wider than those of the other body areas. Following the cerebral longitudinal fissure from the inside to the outside, the motor homunculus is configured as the upper limb, hand, fingers, face, lip, and tongue area in that order. So we suppose that the mouth is related to the hands. Activity in the brain during movement of the hand is shown in the superior temporal sulcus posterior part. In contrast activity in the brain during movement of the mouth is shown in the superior temporal sulcus forefront part^{1,2)}. So there is a close connection between the hand and mouth.

Stomatognathic system contains masseter muscles, teeth, and both side of temporomandibular-joint (TMJ), that used in the process of swallowing, speaking and chewing. The components of stomatognathic system influence each other mutually³⁾. The masseter muscles, that are important part stomatognathic system, control masticatory move-

ment⁴⁾. These are under the control of the trigeminal nerve and make TMJ work to open and close the mouth.

The temporalis and masseter muscles are masticatory muscles⁵⁾. The MORA is used to correct problems arising from excessive muscle use⁶⁾. The MORA was first used in the treatment of bruxism, to provide stable occlusion. In addition, MORA affects the temporal muscle and masseter muscle while decreasing the inhibitory feedback action of periodontal membrane receptors. It has also been used for the reduction of trauma and improvement of strength in sports medicine. MORA is not only used for conservative therapy for hyperplasia of the temporal muscle and masseter muscle, it is also effective at reducing excessive muscle use⁷⁾.

In this study, we measured the maximum isometric contraction of masticatory muscles of wearers of a MORA, to clarify the relationship between grip strength maximum isometric contraction and the masticatory muscles. Our aim is to provide basic clinical data in order to clarify the relationship between the function of the hand and facial malocclusion and its features.

SUBJECTS AND METHODS

For this study, we enrolled 28 adult Koreans who met following selection criteria: those had no difficulty performing the tasks of the study; those who had no history of neurological or systemic medical conditions; those who had no history of injury to the brain or head; those who

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had not experienced injury to the mouth or face within the last 3 years; those who had not experienced musculoskeletal disorders of the upper extremity within 1 year; those who were not wearing a splint in the oral cavity, those who could understand and perform the researchers' instructions; and those who consented to take part in this research. Written informed consent was obtained from all subjects after a full explanation of the experimental purpose and protocol. Moreover, experimental protocol in this study was approved by the Ethical Committee for Human Research.

Our definition of MORA includes the mouth guard that has been developed using a variety of materials and methods. Hard type splint020 (Easy-VAC Gasket splint, 3A MEDES, and Korea) were used as the materials in the making of the MORA for this study. Ortho-Jet (fast curing orthodontic acrylicresin Lang Dental, USA) was used as the occlusion settings of the hard type MORA. Impression taking was performed using alginate impression materials to obtain samples of the maxilla and mandible.

When taking the impression of mandibular centric bite, the influence of the muscle on the teeth were excluded. Some cotton roll was bitten on both sides of the posterior oral cavity and the bite was maintained for 5 minutes. In addition, the impression was in the horizontal position to exclude the influence of gravity on the mandible.

The maxillary cast attached the semi-adjustable articulator with a face-bow to the maxillary and mandibular cast articulator mounting.

Arbitrarily points were marked on the gingiva between the first premolar to the right of the canine tooth of the maxillary and mandibular casts. The distance between the maxilla and mandible on the casts was measured between these points. Each incisal guide pin of the articulator was lifted to be in a position of 3 mm.

The prepared foundation of the MORA was attached to the maxillary working cast. All the teeth in the centric occlusion were in uniform contact. Canine guidance was given during lateral movement of the left and right. During anterior movement, it was controlled by a self-curing resin in order to give anterior guidance uniformly dens incisivus group.

The MORA was put in the oral cavity of each subject, and the centric relation and centric occlusion were matched. All the teeth were adjusted to uniformity in order to mutually protect occlusion. The dens incisivus group was given anterior guidance during anterior movement, and canine guidance was given by the canine teeth during lateral movement. The adjusted occlusion and the occlusal vertical dimension setting were confirmed.

We used a Jamar Pinch Gauge (Hydraulic Pinch Gauge PC 5030HPG, USA) and Jamar Dynamometer (Hydraulic Hand Dynamo-meter, PC 5030, USA) to measure grip and pinch strength. All subjects was provided level 2 considering size of grip and position with their shoulder adducted and neutrally rotated, the elbow flexed at 90°, and the forearm and wrist in the neutral position during maximum isometric contraction of hand pinch grip and hook grip. We measured three times each pinch and hook strength with and without the MORA. Subjects were given a one minute

break between the pinch grip and hook grip measurements, and a three-minute break between wearing and not wearing the MORA. The average of the three measurements were calculated.

Regardless of whether wearing the MORA or not, muscle activity electrodes were first attached to the surface skin over the muscles in the resting position and muscle activity was measured. Then, subjects were given a one-minute break. We measured the muscle activities of maximum isometric contraction during hand pinch grip and hook grip without the MORA, with one-minute break between measuring hand pinch grip and measuring hook grip.

Next, we attached the MORA to the subject and measured the muscle activities of maximum isometric contraction during hand pinch grip and hook grip, with a one-minute break between measuring hand pinch grip and hook grip, in the same manner as before. Subjects were given three-minute break between measurements without and with the MORA.

This study used an 8-channel electromyography (Myo-system TM DTS, Noraxon Inc., USA) to measure the muscle activities of maximum isometric contraction of the masticatory muscle, flexor bundle muscle, and extensor bundle muscle without and with the MORA. The Myo Research XP master edition 1.06 program was used to record and process the electromyogram signals: sampling rate 1000 Hz, band-pass filter 20–500 Hz, notch filter 60 Hz. The electrodes (IWC-DTS, 9113A-DTS) were attached to the attachment locations after shaving the area and reducing the surface resistance by sanding. The electrodes were attached to the muscle belly of the forearm extensor bundle, forearm flexor bundle, and masseter. Subjects sat stood with their shoulder adducted and neutrally rotated, elbow flexed at 90°, and the forearm and wrist in the neutral position during maximum isometric contraction of hand pinch grip and hook grip. Maximum isometric contraction of the masticatory muscle was measured.

Measurements were taken for 5 seconds during muscle activation. The root mean square values were calculated and normalized to the resting voluntary contraction (RVC) value and are presented as percentage (%RVC). We used the averages of the muscle activity values of the middle three seconds, ignoring the first and last one second of the five-second measurement. The results were processed using SPSS 20.0 for Windows. We used the paired t-test to examine the significance of differences in the %RVC values of the three muscles and hook and pinch strengths during hand pinch grip and hook grip with wearing MORA and not wearing MORA.

RESULTS

There were significant differences in muscle activities between wearing MORA and not wearing MORA ($p < 0.05$) (Table 1). Muscle activity was greater when wearing MORA than not wearing MORA. The averages of hook and pinch strength were also significantly greater when wearing MORA than not wearing MORA ($p < 0.05$) (Table 2).

Table 1. Comparison of muscle activity between wearing and not wearing a MORA

		not wearing MORA	wearing MORA
Masseter	Pinch*	3,433.4±526.4	4,324.5±452.0
	Hook*	3,702.4±566.4	4,714.3±350.6
Forearm flexor bundle	Pinch*	5,287.9±233.0	6,083.5±375.6
	Hook*	13,703.2±1,317.1	14,932.1±1,415.4
Forearm Extensor bundle	Pinch*	7,379.6±1,202.0	8,621.9±1,562.2
	Hook*	16,088.0±3,060.7	18,914.0±3,650.5

unit: %RVC, mean±SE, *significant difference ($p<0.05$)

Table 2. Comparison of grip strength between wearing and not wearing a MORA

	not wearing MORA	wearing MORA
pinch*	8.7±0.4	9.4±0.4
hook*	33.0±2.7	34.8±2.6

unit: lbs, mean±SE, *significant difference ($p<0.05$)

DISCUSSION

Wearing MORA has already been addressed by many studies. Results reported in the literature differ due to differences in the method such as the usage time of MORA, adequacy of the positional relationship of the lower jaw, and the experimental control group. For example, some studies⁷⁾ report that MORA has no significant effect on muscle strength increase in the upper and lower body, but other studies⁸⁾ report that when wearing MORA, the upper and lower jaw relationship changed, so exercise capacity and muscle strength increased in the upper and lower body. Therefore, no consensus has been established because of these conflicting results.

In this study, the maximum isometric contraction of the masticatory muscles with respect to the mechanism of the function of the upper extremity, as measured by two grip strength was evaluated.

The subjects were normal persons in their twenties. In the experiment, subjects performed masseter muscle iso-

metric contraction, at the same time as upper limb muscles (flexor, extensor) isometric contraction with and without the MORA. The contractions were performed within the range that does not cause muscle fatigue, and we measured the muscle activities using EMG. The results show that EMG activities of the masseter, upper limb flexor and extensor muscles significantly increased when wearing MORA. This result means that when wearing MORA, the upper limb muscle power increase. The reason why the muscle power of the upper limbs increased when wearing MORA is because it provided occlusal stability during isometric contraction of the masseter muscles⁷⁾.

Based on the results of the masticatory muscle activity when wearing a MORA, we consider the function of upper limb was enhanced. As a result, upper extremity strength can be enhanced.

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