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Original Article

Peak Torque and Average Power at Flexion/Extension of the Shoulder and Knee when Using a Mouth Guard in Adults with Mild Midline Discrepancy

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Abstract. [Purpose] This study was conducted to investigate the changes in torque and power during flexion and extension of the shoulder and the knee joints caused by midline correction using mouth guards made from different materials in adults with mild midline discrepancy. [Subjects] The subjects of this study were males (n=12) in their 20s who showed a 3–5 mm difference between the midlines of the upper and lower teeth but had normal masticatory function. [Methods] The torque and average power of the lower limb and upper limb were measured during flexion and extension according to various types of mouth guard. [Results] There were significant differences in relative torque and average power between three conditions (no mouth guard, soft-type mouth guard, and hard-type mouth guard) at shoulder flexion and extension. There were no significant differences in relative torque and average power between the three conditions at knee flexion and extension. [Conclusions] These results suggest that use of a mouth guard is a method by which people with a mild midline discrepancy can improve the stability of the entire body.
Key words: Mouth guard, Mild midline discrepancy, Stability

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INTRODUCTION

The temporomandibular joint, which is structurally the closest joint to the upper cervical spine, is the only bilateral joint in human body[1)]. The mandible, one of the components of the joint, is between the head and the spine, and a change in its position leads to a different head posture. The changed head posture affects the vestibular system and eye movement function[2)]. Stability of head posture enhances posture balance development by promoting visual information processing[3)]. The temporomandibular joint is considered to be a functional link of the cervical spine and head posture[4)].

An incorrect position of the mandible makes the atlas and the axis take an abnormal posture, and eventually the head, shoulder, spine, and pelvis are no longer held in a normal posture. This change into an abnormal posture affects upper and lower limb movement by reducing balance at the proximal part of the human body[5)]. In addition, this leads to a negative influence on control of muscles around the shoulder and spine[6)].

A sudden and strong movement of the four limbs provokes a large biting force, which increases the contact surface of the teeth[7)]. For an adult with mild midline discrepancy, contact in discord with the midline induces imbalanced contraction of the masseter muscle and an abnormal position of the bilateral temporomandibular jont[8)].

A mouth guard decreases impact associated with a strong friction of the teeth by hindering direct teeth contact of the teeth[9)] and maintains equal bilateral temporomandibular joint gaps. Based on the characteristics of a mouth guard, the aim of this study was to analyze the effects of midline correction of a mouse guard on peak torque and average power of the upper and lower limbs based on degree of solidity in subjects with mild midline discrepancy.

SUBJECTS AND METHODS

The subjects of this study were males (n=12) in their 20s who showed a 3–5 mm difference between the midlines of the upper and lower teeth but had normal masticatory function. The mean age, height, weight, and midline distance of the study subjects were 23.56 years old, 172.6 cm, 69.5 kg, and 3.7 mm, respectively. Written informed consent was obtained from all subjects after a full explanation of the experimental purpose and protocol of the study. Moreover, the experimental protocol in this study was approved by an inquiry committee for studies on humans. This study was

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Table 1. Relative torque and average power at the shoulder (n=12)

		None	Soft	Hard
Flexion	Relative torque (%) *	74.8±6.3†	78.8±4.7†	83.9±3.8‡
	Power (W) *	62.6±2.4†	67.5±6.0‡	72.1±3.8†‡
Extension	Relative torque (%)*	81.2±4.9†	87.0±4.5‡	92.1±4.4†‡
	Power (W) *	119.8±12.1†	131.0±8.5‡	136.9±6.0‡

Each value represents the mean ± SD. The values with different superscripts (†, ‡) in the same column are significantly different (p<0.05, Tukey's method).
*p<0.05. Relative torque, Peak torque %BW; Power, Average power

Table 2. Relative torque and average power at the knee (n=12)

		None	Soft	Hard
Flexion	Relative torque (%)	130.9±24.2	131.6±17.8	132.9±20.3
	Power (W)	114.8±30.9	114.4±31.5	122.3±24.8
Extension	Relative torque (%)	246.4±25.2	243.3±19.4	249.9±18.4
	Power (W)	196.4±38.8	205.8±33.0	207.7±33.6

Each value represents the mean ± SD.
Relative torque, Peak torque %BW; Power, Average power

approved by Kyungsung University's Human Research Ethics Committee.

This study measured peak torque and average power at isokinetic contraction to determine the effect of midline correction of a mouth guard on the upper and lower limbs according to its use and materials. A Cybex system (Cybex International Inc., Medway, MA, USA) was used for measurement. The shoulder joint and knee joint were designated as representative joints of the upper and lower limbs, respectively. The dominant side was examined for all subjects and the thigh and the trunk in a sitting position were fixed to the examination table with a belt to prevent compensation. The movement axis of the device was controlled to be consistent with the axis of the examined joint. One of three conditions and a measured joint were randomly chosen. After three-time exercise at an angular speed of 120°/sec, the experiment was conducted. Regardless of the use of a mouth guard, a measured value was obtained when the temporomandibular joint was tightened maximally in each condition. Peak torque and average power were measured three times at the maximal flexion and extension with a two-minute rest break between measurements. The average of three measured values was analyzed in this study.

The experimental mouth guards used in this study were made by following the method for producing a custom-made type of mouth guard (CMT), which makes use of a model after obtaining an impression[10]. They were placed inside the mouth of a subject to relocate the midline of the mandible to the midline of the maxilla laterally, vertically, and horizontally for the subjects with mild midline discrepancy at centric occlusion. To produce various degree of solidity, soft Elite HD+ Putty (Zhermack, Badia Polesine, Italy) and hard type Platinum 95 putty (Zhermack, Badia Polesine, Italy) were used as vinyl polysilane impression material.

The data were analyzed with SPSS 18.0, and one-way ANOVA was conducted to investigate peak torque and average power during flexion and extension of the shoulder and the knee joints affected by midline correction using mouth guards made from different materials. Tukey's method was used as a post hoc test to analyze differences in each condition. The significance level α was 0.05 for all data analyses.

RESULTS

There were significant differences in relative torque and average power between three conditions (no mouth guard, soft-type mouth guard, and hard-type mouth guard) at shoulder flexion and extension (p<0.05; Table 1). There were no significant differences in relative torque and average power between the three conditions at knee flexion and extension (Table 2).

DISCUSSION

This study was conducted to investigate the changes in torque and power during flexion and extension of the shoulder and the knee joints caused by midline correction using mouth guards made from different materials in adults with mild midline discrepancy.

The results of this study showed that higher solidity of a mouth guard increased torque and power during movement of the shoulder joint. This means that a hard-type mouth guard provides stability of the cervical spine and the shoulder by preventing an abnormal change in location of the temporomandibular joint associated with a strong bite force in subjects with mild midline discrepancy. This finding is consistent with that by a study of Lee et al[10]. They reported that use of a mouth guard at a strong biting force with respect to the temporomandibular joint increased muscle activation of the trunk and upper limbs by maintaining equal bilateral temporomandibular joint gaps. Moreover, the temporomandibular joint is the closest joint to the vestibular system largely contributing to balance and posture of the body, and it is the only bilateral joint moving on both sides at the same time in the human body[11]. For this reason, use of a mouth guard to help maintain a consistent gap on both sides is considered to be able to promote physical activities by maintaining the balance of the temporomandibular joint. This suggests that a hard-type mouth guard produces higher torque and power because it can maintain the gap more consistently.

In addition, torque and power are thought to increase through normalization of the balance of the temporomandibular joint by hindering midline transition during the occurrence of a strong bite force in subjects with mild midline discrepancy, thanks to midline correction. This finding supports that of a previous study[12] indicating that the arrangement of the neck and the jaw was closely related.

However, midline correction using mouth guards made from the different materials did not affect the lower limbs. This is considered to be because fixation of the pelvis rather than midline correction influences torque and power measured in a sitting position in which the pelvis is fixed. Although this finding is contrary to that of a previous study[13] showing that the use of a mouth guard changed the posture of the lower limbs, the difference is thought to be caused by the difference in the position used for the measurements. Measurement in a standing position is needed in the future.

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