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Invited Paper

Effective Mouth Gymnastics for Orbicularis Oris Muscle

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Abstract. There is a tendency that the elderly persons decline in feeding and swallowing. It is known that the oral training such as a facial exercise has an effect to facilitate a smoothness swallowing motion. This paper describes a perspective on measurement and evaluation of face movements in the oral training practices, based on the electromyography (EMG). Here, the zygomaticus major and minor muscles, and orbicularis oris muscle were focused for an evaluation. As a result of APDF analysis, it could be confirmed that the motion of puffing the cheeks and the vertical movement of the mouth corner had an effect to enhance the activity of the mouth muscles.

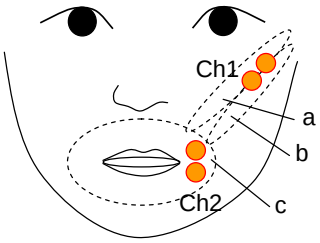
1. Introduction

Motion to swallow food and a drink are called "deglutition". The decline of oral sensation and the salivation with aging tends to decrease the function of the deglutition. As for some elderly, food and a drink are clogged up to the bronchus and may cause pneumonia. In the serious case, the nourishment is taken through a pipe, and the pleasure of the original meal will be lost by a nasal cavity. In order to facilitate a smoothness swallowing, it is known that the dysphagia by aging can be prevented by training oral neighborhood source and face exercises [1][2]. In addition, the mouthpiece-formed product to train oral neighboring sources has been developed [3]. This paper treats a perspective on measurement and evaluation of face movements in the oral training practices for the purpose of the prevention of dysphagia. About the effect of face exercises, inspection is formed so far by quantity of salivation and opening degree, repetition saliva deglutition test [1] lips closedown power and syllable alternation repetition campaigns [2]. Here, we evaluated the oral training practices based on the electromyography (EMG). The zygomaticus major and minor muscles and orbicularis oris muscle were focused to consider the optimal practices.

2. Muscular activity of face practices

2.1 Measurement

With reference to the exercises for the purpose of the improvement of the oral cavity function, namely, mobility and activity, there are the exercise of neck and shoulder, opening and shutting of the mouth, lips and tongue, cheeks blow up, and utterance. Here, we paid attention to the movement of lips and cheeks from face exercise and measured the EMG signal. As shown in Fig.1, the electrodes were put near orbicularis oris muscle and zygomaticus major muscle and zygomaticus minor muscle, a ground was attached to a wrist. The electrode unit (Biometrics SX230) of the dry



a. Zygomaticus minor muscle
b. Zygomaticus major muscle
c. Orbicularis oris muscle

Fig.1 Measurement points of EMG

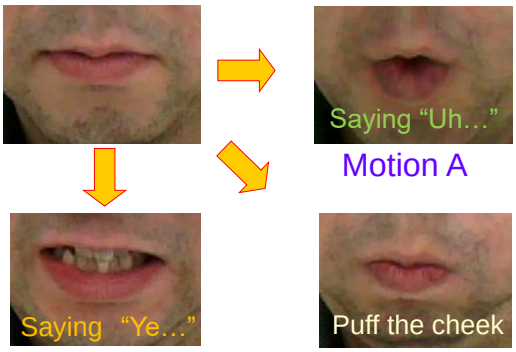
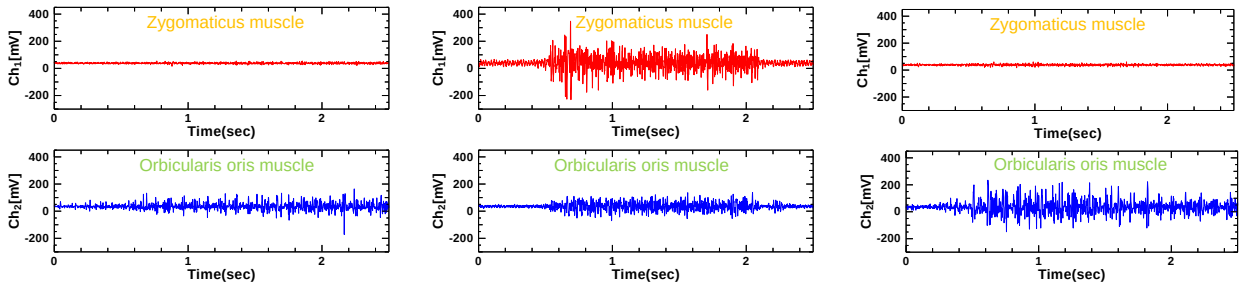


Fig.2 Scene of the oral training



(a) Motion A (b) Motion B (c) Motion C

Fig.3 Time series of data of EMG

type was used for a measurement. The obtained EMG signal was taken to the personal computer with sampling frequency of 600[Hz].

2.2 Face practices

Fig.2 shows the lip and cheek postures when the face exercises were carried out. This figure includes three states from normal state to each state, pouting with saying "Uh…"(Motion A), spreading the corner of the mouth with saying "Ye…"(Motion B), and inflating the cheek (Motion C). In the practice of Motion A and Motion B, the muscle around the mouth is strengthened and it is effective in preventing food from running it down from a mouth. As for the practice of Motion C, it is intended to strengthen the muscle of the circumference of the mouth and the throat.

2.3 EMG signal and APDF analysis

Typical time trajectory of Motion A, Motion B, and Motion C are shown in Fig.3. The EMG signal of the zygomaticus major and minor muscles and the orbicularis oris muscle are assigned to Ch1 and Ch2, respectively. This evaluation is very often used [4][5]. In the exercise to pout over (Motion A), shown in Fig.3 (a), the orbicularis oris muscle is active while there are few changes in the activity of the zygomaticus major and minor muscles. In the exercise to widen the corners of the mouth (Motion B), shown in Fig.3 (b), both muscle parts are active. With reference to the exercise to inflate the cheek (Motion C), shown in Fig.3 (c), the amplitude level of the orbicularis oris muscle is larger, compared with Motion A and B. Here, the amplitude probability distribution (APDF) of the obtained data was computed. It is used for an evaluation of a muscle burden [4][5]. Fig.4 shows the enlarged view of the time trajectory of EMG signal. Let be the i th appearance time duration when the amplitude of the EMG signal became more than x% of the EMG maximal voluntary contraction (MVC), the value of APDF can be expressed by the following equation.

$$P = \frac{1}{T_{toral}} \sum_{i=1}^{N} T_i \times 100 \quad (1)$$

Here, we derived the maximum amplitude of the EMG signal from whole trials in individual, which was set to the MVC. Fig.5 shows the APDF example of three practices. In this figure, the typical data of the orbicularis oris muscle was picked up. Note that the activity of the muscle can be regarded as higher if the percentage with respect to P=0.5 is higher. From this figure, it is found that the percentage of Motion C with respect to P=0.5 is higher than other motions and the exercise of inflating the cheek is effective for the training of the orbicularis oris muscle.

2.4 Mouth exercises

Next, we investigated the knack of the mouth excises for effective training. Fig.6 shows the experimental results of changes in the mouth open width, horizontal and vertical movement of the mouth corner. The excise of opening mouth (Fig.6(a)) is relatively small, compared with the excise

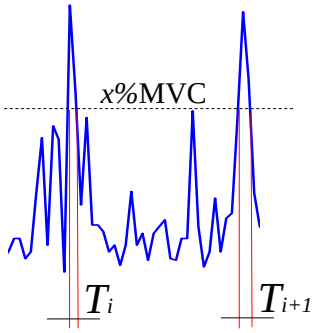


Fig.4 APDF analysis

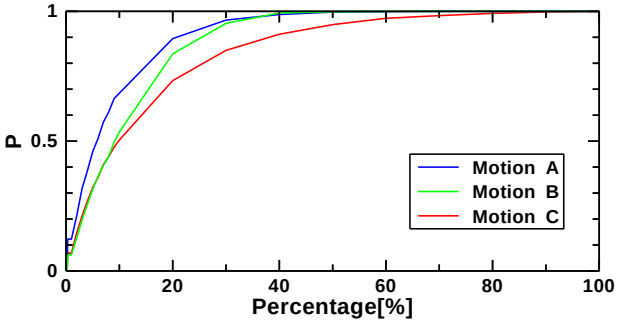
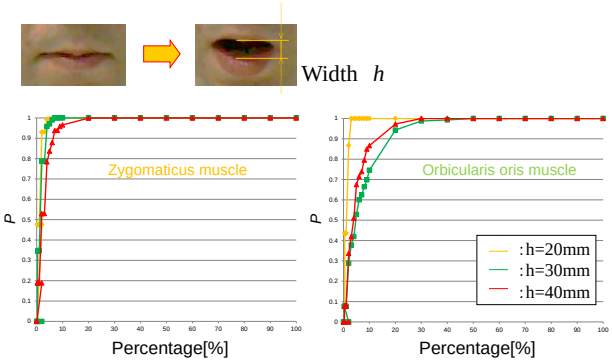
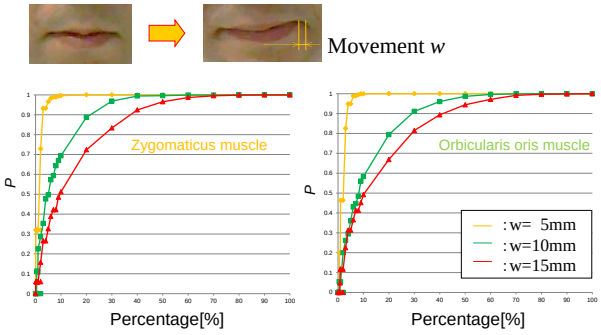


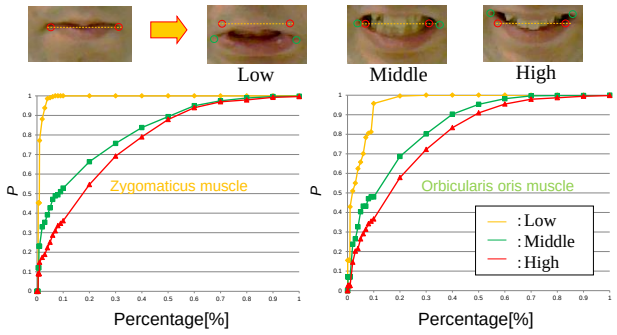
Fig.5 APDF example of three practices



(a) Open width



(b) Horizontal movement of corner



(c) Vertical movement of corner

Fig.6 APDF of the mouth excises

of moving the mouth corner (Fig.6(b) and (c)). In this case, the zygomaticus muscle is regarded as low active. In Fig.6(b) and (c), it can be confirmed that the activity of both the zygomaticus muscle and he orbicularis oris muscle are active and it becomes a higher activity as the movement of the mouth corner is larger. Especially, the vertical movement of the mouth corner has a higher percentage with respect to P=0.5 and it can be considered as an effective for the oral training.

3 Conclusions

In this study, we investigated the face exercises through the measurement of the EMG around the oral cavity. Here, the zygomaticus major and minor muscles, and orbicularis oris muscle were focused for an evaluation by using APDF analysis. As a result, it could be found that the motion of puffing the cheeks and the vertical movement of the mouth corner had an effect to enhance the muscle activity of the mouth. As a future works, we would like to construct the mouth training GUI based on the effect practices.

Acknowledgements

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