



Original Article

Relationship between the nutritional state of elderly people in need of support or nursing care and jaw-opening force and tongue pressure

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Abstract. [Purpose] We hypothesized that an association exists between the nutritional state of elderly people and the deterioration in the swallowing function associated with sarcopenia, which is reflected by the strength of the tongue and suprahyoid muscles. Therefore, we conducted a comparative study of the nutritional state and swallowing muscle strength. [Participants and Methods] The participants in this study were 25 elderly people in need of support or nursing care, situated at a geriatric health service facility, who were able to understand instructions and ate three meals per day orally. We evaluated the strength of the tongue muscles using a tongue pressure measurement device and the strength of the suprahyoid muscles by measuring the jaw-opening force. The nutritional state was evaluated using the Mini Nutritional Assessment. [Results] There was a significant correlation between the Mini Nutritional Assessment score and the jaw-opening force. Conversely, no correlation was found between the Mini Nutritional Assessment score and the tongue pressure. [Conclusion] The significant correlation between the Mini Nutritional Assessment score and the jaw-opening force suggests that the strength of the suprahyoid muscles, which reflects the swallowing function and jaw-opening force, deteriorates with age and is affected by the nutritional state. This suggests that the nutritional state could be an important indicator for the evaluation of the swallowing function.

Key words: Tongue pressure, Jaw-opening force, Nutritional state

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INTRODUCTION

Sarcopenia is believed to be one of the primary factors in the deterioration of the swallowing function in elderly people. Sarcopenic dysphagia refers to deterioration of the swallowing function due to deterioration of the strength, volume, and function of the skeletal muscles linked to swallowing¹⁻³⁾. Many studies on sarcopenic dysphagia have been published in recent years⁴⁻⁶⁾. In Japan, Wakabayashi and Fujimoto have advanced the concept of sarcopenic dysphagia³⁾. Maeda et al. reported that sarcopenia is an independent risk factor for dysphagia in hospitalized elderly people⁵⁾. Furthermore, Maeda et al. also suggested the possibility that hospitalization may trigger dysphagia, reporting that approximately 40% of hospitalized elderly people without history of cerebrovascular disease, who were unlikely to develop dysphagic conditions, were found to have dysphagia⁶⁾.

Therefore, in an ageing society, it is necessary to take countermeasures against sarcopenic dysphagia, and it is important that evaluation methods be accurate. Recent studies have discussed the relationship between sarcopenia and deterioration of the muscles involved in swallowing, using tongue pressure and jaw-opening force to measure the strength of these muscles⁷⁻⁹⁾.

Earlier studies have reported that tongue function deteriorates with age¹⁰⁻¹³⁾. In a study that measured the tongue pressure

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of 843 healthy individuals, Utanohara et al. found that the maximum tongue pressure among participants in their 70s was low compared to in young participants¹⁴. Takeuchi et al. measured the tongue pressure of a group of participants with dysphagia or lisps, and that of a control group of the same age group without swallowing problems or lisps, and found a decrease in tongue pressure among the former¹⁵. Kodama et al. measured the maximum tongue pressure of institutionalized elderly people requiring nursing care and found that tongue pressure is linked to factors such as choking while eating or the shape of the food¹⁶. Based on these reports, it can be concluded that a decrease in tongue pressure in elderly people affects the swallowing function.

Tohara et al. developed a device to measure the jaw-opening force, drawing attention to the fact that the mylohyoid muscle, the anterior belly of the digastric muscle, and the geniohyoid muscle, which are suprahyoid muscles associated with swallowing, are also muscles that are used for opening the jaw¹⁷. They reported a correlation between the jaw-opening force and grip strength. Hara et al. used this device to conduct a study of the relationship between the jaw-opening force, pulmonary aspiration, and pharyngeal residue among chronic dysphagia patients, and reported that the group with pulmonary aspiration and pharyngeal residue had reduced jaw-opening force compared to the group without¹⁸. Based on the above studies, it can be concluded that the jaw-opening force is related to the swallowing function.

In elderly people, a decrease in the swallowing function caused by sarcopenic dysphagia can exacerbate the dysphagia; moreover, contracting an illness or sustaining an injury is likely to trigger the deterioration of the swallowing function. Undernourishment is one of the primary factors in the aggravation of sarcopenia, so the evaluation of the nutritional state is important for the prevention and management of sarcopenic dysphagia. In this study, the relationship of the nutritional state of elderly people who required support or nursing care with tongue pressure and jaw-opening force was investigated.

PARTICIPANTS AND METHODS

The research protocol was approved by the ethics review board at Nittazuka Medical Welfare Center (approval number 28-30). The objectives and methods of the research were explained to the participants, and informed consent was obtained.

The participants were 25 elderly people (8 males, 17 females) in need of support or nursing care at a geriatric health services facility who were able to understand instructions and who ate 3 meals a day orally. The average age of the participants was 85.8 ± 5.7 years, and the average level of care was 1.98.

Tongue pressure was measured with a tongue pressure measurement device (JMS Co., Ltd., Hiroshima, Japan)¹⁴. Participants were in a seated position during measurement and were instructed to hold the hard ring at the base of the probe balloon lightly between their anterior teeth, to close their lips, and to flatten the balloon against the roof of the mouth with the tongue as strongly as they could. The tongue pressure was measured 3 times.

The jaw-opening force was measured with a jaw-opening force measurement device (jaw-opening force trainer KT2016, Livet Inc., Tokyo, Japan)^{17, 18}. Participants were in a seated position wearing the device during measurement. After fixing the head and chin together as firmly as possible with a belt, the participants were instructed to open their mouths as forcefully as possible. Their jaw-opening force was measured 3 times. Nutritional state was assessed using the Mini Nutritional Assessment (MNA).

For statistical analysis, the Pearson correlation coefficient was used to assess the relation between MNA score and jaw-opening force and tongue pressure. The significance level was set at 5%. Statistical analysis was performed using SPSS ver. 25.

RESULTS

The average MNA score was 22.5 (standard deviation [SD]=3.77, range: 15–28.5).

The average tongue pressure was 22.0 kPa (SD=8.2, range: 1.2–7), and the average jaw-opening force was 3.2 kg (SD=1.2, range: 5.8–36.8).

A significant correlation was found between MNA and the jaw-opening force ($r=0.49$, $p=0.01$) (Fig.1). A significant correlation was not found between MNA and tongue pressure ($r=0.15$, $p=0.47$) (Fig.1).

DISCUSSION

In this study, the relationship between the nutritional state of elderly people who required support or nursing care and the tongue pressure and jaw-opening force was investigated. A significant correlation was observed between MNA and the jaw-opening force, but no correlation was observed between MNA and the tongue pressure.

The reason why there were no participants with MNA scores of 14 or less, may be because all the participants were able to partake 3 meals orally, had a stable general condition, and many participants could have their meals independently.

The reason for the lack of correlation between MNA and tongue pressure may be related to the characteristic distribution of the muscle fibers of the tongue. Sanders et al. noted that the tongue muscles are largely made up of type 1 fibers, which do not degenerate as easily¹⁹. Therefore, it is possible that the tongue pressure was not much affected by the participants' nutritional state.

In a study of 386 frail elderly people, Wakabayashi et al. found that head-raising ability and swallowing function were

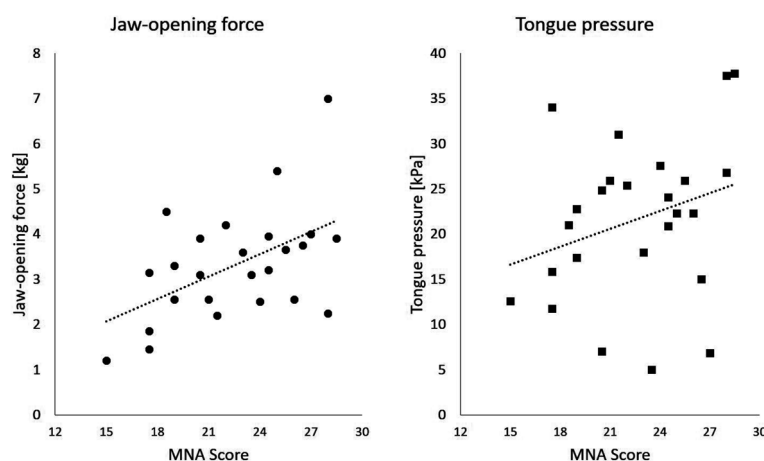


Fig. 1. Relationship between jaw-opening force, tongue pressure and Mini Nutritional Assessment (MNA) score.

MNA was scored by speech language hearing therapist on the basis of the measurement of participants and information from other occupations. Tongue pressure was measured with a tongue pressure measurement device (JMS Co., Ltd.)¹⁴. The jaw-opening force was measured with a jaw-opening force measurement device (jaw-opening force trainer KT2016, Livet Inc.)^{17, 18}. The average MNA score was 22.5 (Standard deviation (SD)=3.77, range: 15–28.5). The average tongue pressure was 22.0kPa (SD=8.2, range: 1.2–7), and the average jaw-opening force was 3.2 kg (SD=1.2, range: 1.2–7). A significant correlation was found between MNA and the jaw-opening force ($r=0.49$, $p=0.01$). A significant correlation was not found between MNA and tongue pressure ($r=0.15$, $p=0.47$).

linked to undernutrition²⁰). In a study of elderly men by Feng et al., it was observed that the group with pulmonary aspiration had a significant decrease in the geniohyoid muscle volume compared to the group without pulmonary aspiration²¹). The muscles of the neck are antigravity muscles and are known to easily become sarcopenic²²).

In the present study, the reason that an association was found between MNA and the jaw-opening force (which reflects the strength of the suprahyoid muscles) may be due to the fact that the suprahyoid muscles, which are neck muscles that degenerate easily with age, are easily affected by the nutritional state and are thus more likely to show a deterioration in muscle strength.

With regard to the mechanism of onset of sarcopenic dysphagia, according to Wakabayashi, dysphagia is triggered by factors that exacerbate sarcopenia in frail elderly people, such as, undernutrition, invasive procedures, and lack of muscle use²³). Thus, nutritional state can be regarded as a significant factor in the deterioration of the swallowing function among elderly people. Furthermore, it has been reported that elderly people with reduced mandibular mobility have limited dietary intake²⁴). In terms of the frailty cycle model, sarcopenia and malnutrition are related, and from the frailty cycle²⁵). Therefore, oral frailness and sarcopenia are considered to be factors promoting malnutrition.

In the present study, an insufficient number of participants could have caused type 1 errors. Moreover, since there were more women participants than men in the study, differences due to gender or degree of care may have influenced the results. Future studies will require calculation of an appropriate sample size based on the results of this study to ensure an adequate number of participants, and regulation of factors, such as gender and degree of care.

This report suggests that the strength of the suprahyoid muscles deteriorates with age, and nutritional state is an effective indicator of the deterioration. Based on the results obtained using the jaw-opening force measuring device, the strength of the suprahyoid muscles may be weakened by malnutrition, as assessed by MNA.

Conflict of interest

The authors declare no conflicts of interest associated with this manuscript.

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