学会賞受賞講演

顎舌反射の中枢性変調機構

Central modulations of jaw and tongue reflexes

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Introduction

There are many jaw reflexes involved in defense mechanisms and control of masticatory force. However, the contribution of reflex to ongoing masticatory behavior is questionable. Recent studies have revealed that the jaw-opening reflex (JOR) may be suppressed during chewing and the degree of suppression depends on the chewing phase and the modality of stimulus. Therefore, it is possible that the time of initiation of reflexes might be modulated centrally according to the situation (i.e., resting, chewing, sleeping, etc). Central modulation on the initiation of reflexes such as JOR, jaw-closing reflex, tongue reflex, and swallowing reflex have been studied using an original experimental system, in which jaw movement trajectories in the frontal plane, jaw and neck muscle activities, EOG, and unit activities in the mesencephalic nucleus can be recorded in the awake and freely behaving rabbit. In this session, I will introduce some of our results.

Modulation of JOR during mastication[1) 2)]

The JOR evoked by the electrical stimulation of the inferior alveolar nerve was studied during chewing in freely behaving rabbits. The reflex was found to be tonically depressed during the masticatory cycle and the inhibition of the reflex was rhythmically modulated in a phase-linked manner that was larger in the opening phase than in the closing phase. Subsequent study was carried out to elucidate the effects of food consistency on the reflex. The results suggested the followings: (1) food consistency may affect the central mechanism, which regulates the digastric (Dig) reflex, and (2) the reflex may contribute to the regulation of masticatory force particularly during chewing hard food.

Modulation of motoneuron excitability in masticatory muscles during sleep[3)]

Changes in the reflex responses of the masseter (Mas) and Dig muscles during sleep and wakefulness were recorded in freely behaving rabbits. The results indicated that there was a difference mainly in the excitability between the two groups of motoneurons during active sleep; Mas motoneuron activity was inhibited but occasionally facilitated by excitatory inputs occurring in association with rapid eye movements, however, the Dig motoneuron activity was remained inhibited. The excitatory inputs may induce dysfunctional muscle contraction of the jaw closing muscles as seen in bruxism. We assume that the activity of the hypothalamus and associated limbic structures, which are strongly associated with the expression of emotions, has a critical role in the development of bruxism. Thereafter, we studied the effects of the electrical stimulation of the lateral hypothalamus on jaw reflexes in anesthetized rabbits. It was observed that a facilitatory effect on the masseteric reflex and an inhibitory and/or facilitatory effect on the jaw-opening reflex. We assumed that there were two reciprocal regions in the lateral hypothalamus that separately projected to the jaw opening muscles.

Modulation of tongue reflex during mastication[4) 5)]

Firstly, the function of the tongue and the coordination among jaw, tongue, and hyoid muscles during chewing and swallowing were studied. Three phases were identified in the chewing cycle (i.e., opening: OP, fast-closing: FC, and slow-closing: SC). The genioglossus (Gg: main tongue protruder) was active synchronously with the Dig during opening. The styloglossus (Sg: tongue retractor) showed two peaks in each cycle, one in the OP phase and the other in the closing phase. The latter may have a role in retracting the tongue during jaw closing. The co-contraction of the antagonists (i.e., Gg and Sg) during opening may contribute to shape the tongue to be appropriate to gather the foodstuff. In the swallowing cycle, five phases were identified, two in the closing phase and three in the OP phase. Regression analysis revealed that swallowing cycles had a longer cycle duration than that of the chewing cycles due to an extra phase (a pause) inserted in the OP phase, where there was a small co-activation in the jaw opening and closing muscles. The findings suggest that the swallowing center affects masticatory center in the central nervous system, and may also support the view that the masticatory burst timing begins with the Dig activities in the middle of the OP phase.

Secondly, the coordination between the masticatory and extrinsic tongue muscles during chewing was assessed by reflex modulation. Reflex responses were elicited in the Gg muscle by electrical stimulation of the inferior alveolar nerve. The amplitude of the Gg muscle reflex measured was divided into three categories depending on the chewing phase in which the stimulus was delivered and each value was compared with the control response obtained when the animal was awake and resting. The amplitude of Gg muscle reflex was phasically modulated for the phases. The reflex amplitude was significantly smaller in the FC and SC phases than that in the OP phase and than that of the control. However, the reflex amplitude in the OP phase was larger than the control value. The pattern of the modulation in the reflex amplitude was different from the precise report as to the Dig reflex, in that OP < FC ~ SC < rest was obtained. The results suggest the followings; the modulatory mode in the Gg muscle reflex and Dig reflex may be different in the pattern of the modulation under the natural chewing behavior, and the Gg muscle reflex is independent of the masticatory muscles in the control nature, so that the reflex could be more sensitive to control the tongue collecting food bolus in the jaw OP phase during chewing than in the closing phase or at rest.

References

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