Morphological study of the sensory nerve which induces jaw opening reflex

Rie Shimotakahara, Kazuharu Mine, Shigemitsu Ogata

1Faculty of Neurology Gross Anatomy Section, Kagoshima University Graduate School Medical and Dental Sciences, Japan
2Department of Clinical Nursing, School of Health Science, Faculty of Medicine, Kagoshima University, Japan

Abstract

Background and objectives: An anatomical site in the oral cavity can be used to trigger the jaw opening reflex in patients with pseudobulbar palsy who have difficulty opening the mouth. The site is located at the midpoint between the palatoglossal arch and pterygomandibular fold and medial to the retromolar pad. However, previous findings on the nerves innervating this particular area are inconsistent. Therefore, in this study, we carefully investigated the sensory nerves that innervate the area near the trigger point of the jaw opening reflex.

Materials and methods: For the morphological investigation of sensory innervation in this area, in this study we exposed the cranial nerves in 26 halves of cadaver head and observed their distribution in soft tissue.

Results: In all cases, several nerve fibers diverged anteroinferiorly from the lingual nerve located between its junction with the chorda tympani nerve and the junction with the communicating branch of the submandibular ganglion. These nerve fibers, thought to be the facial branches of the lingual nerve, innervated the mucosa in the vicinity of the palatoglossal arch, retromolar pad, and the lingual gingiva of the last molar which were near to the trigger point of the jaw opening reflex.

Conclusion: The results suggest that the sensory nerve that induces the jaw opening reflex appears to be the branches to isthmus of fauces diverged from the lingual nerve.

Key words: branch to the isthmus of fauces, lingual nerve, trigger point, jaw opening reflex, palatoglossal arch, retromolar pad

Introduction

Dysphagia, or deglutition disorders, due to stroke is caused by damage to the brain region that regulates deglutition. The deglutition center is located in the medulla oblongata, and the action of this center is believed to be enhanced by the corresponding brain area superior to the medulla oblongata. While dysfunction of this center causes bulbar palsy, deglutition disorders in patients with pseudobulbar palsy is due to damage to the brainstem superior to the medulla oblongata or cerebrum. The deglutition reflex is less likely to occur or occurs insufficiently in patients with bulbar palsy. In patients with the severe symptoms, deglutition is totally inhibited, thereby preventing them from drinking fluids or even deglutition of saliva. On the other hand, in patients with pseudobulbar palsy whose deglutition center in the medulla oblongata is intact, despite initial difficulty, once the deglutition reflex is initiated, a series of movements follow smoothly.

Pseudobulbar palsy is frequently accompanied by higher brain dysfunction, such as dementia, aphasia, and agnosia. There are much greater numbers of patients with pseudobulbar palsy than those with bulbar palsy. Patients with pseudobulbar palsy often refuse to open their mouth, but as long as they can open it widely when yawning, they should have an intact temporomandibular joint and associated muscles as well as intact jaw opening function. An anatomical site in the oral cavity can be used to trigger the jaw opening reflex in patients with pseudobulbar palsy who have difficulty opening their mouth.

The jaw opening reflex is sometimes triggered by lightly pressing the mucosa near the aspect of the retromolar pad (retromolar triangle) with a tongue depressor or a finger. Kojima et al. named this anatomical site the K-point and reported it as a trigger point for the jaw opening reflex in individuals including those with pseudobulbar palsy.
Repeating mouth opening movement in any form is beneficial not only for the recovery of muscular function, but also for oral cavity hygiene. In addition, the jaw opening reflex triggered by stimulation is followed by masticatory movement and deglutition, suggesting that proper application of the jaw opening reflex method will facilitate the recovery of eating and deglutition functions in patients with pseudobulbar palsy.

However, because the jaw opening reflex is not always induced by stimulating the mucosa in the posterior region of the oral cavity, the exact mechanism involved in this reflex remains unclear. The trigger point is located midpoint between the palatoglossal arch and pterygomandibular fold and at the medial aspect of the retromolar pad. Based on this anatomy, the candidate sensory nerves that innervate this area are (1) the branch to the isthmus of fauces of the lingual nerve, which is a branch of the mandibular nerve, and (2) the tonsillar branches of the glossopharyngeal nerve. However, previous reports are unclear or inconsistent on this point. Therefore, in this study, we carefully investigated the sensory nerves that innervate the area near the trigger point of the jaw opening reflex.

Material and methods

The material examined was the lingual nerves, with their associated structures, from Japanese cadavers (26 halves of 13 individuals, 7 males and 6 females, aged from 58 to 83 years old, 63.8 years on the average) from the student dissection course at Kagoshima University Faculty of Dentistry in 2013, and from specimens stored in the department.

The procedure, for the location of the reference point and its relation to the retromolar pad in the oral cavity consisted of their examination to simulate actual clinical settings. Wearing gloves, the examiner slipped an index finger into the area between the molars to identify the medial aspect of the retromolar pad, which was marked with Indian ink for use as an anatomical landmark. By removing the digastric, mylohyoid, and geniohyoid muscles in this order and as much connective tissue as possible by gross dissection, the hypoglossal nerve which runs over the hyoglossus muscle and the lingual nerve which runs laterally to the styloglossus muscle were loosely exposed, while referring to the Indian ink marking. After that, to prevent accidental cutting of small nerve fibers, dissection of the head was performed in water to float the nerves. The protocol for the research project was approved by the Ethics Committee of Kagoshima University, within which the work was undertaken, and the study conformed to the provisions of the Declaration of Helsinki in 1995 (as revised in Edinburgh, 2000).

Results

1. Innervation and branches of the lingual nerve

In the infratemporal fossa, the lingual nerve diverged as one branch of the mandibular nerve, and descended along the medial aspect of the lateral pterygoid muscle and the lateral aspect of the medial pterygoid muscle (Fig. 1). Near the lower margin of the lateral pterygoid muscle, it merged with the chorda tympani nerve. At the lower level of the superior pharyngeal constrictor muscle, it changed direction and proceeded anteromedially through the space lateral to the styloglossus muscle and medial to the mandibular last molar. Then, it proceeded anteriorly along the lateral aspect of the hyoglossus muscle through the area superior to the deep part of the submandibular gland. At the anterior margin of the hyoglossus muscle, it was bended slightly inward to enter the lingual body. In the sublingual area, the lingual nerve gave off the ganglionic, communicating and terminal branches. In all cases, 4 to 6 twigs (counted at the base of branching from the lingual nerve) were diverged anteroinferiorly from the lingual nerve within the area between its junction with the chorda tympani nerve and the ganglionic branches to the submandibular ganglion (Fig. 1). The branches to isthmus of fauces together formed mesh networks and distributed to the mucosa near the palatoglossal arch, retromolar pad, and the lingual
gingiva of the last molar (Figs. 2 and 3). There was no statistically significant difference between the number of right and left twigs (Paired t-test, Table 1).

Table 1: The number of branches to the isthmus of fauces

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<th>Specimen</th>
<th>Side of skull</th>
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Not significant

2. Tonsillar branches of the glosopharyngeal nerve

The tonsillar branches of the lingual branches, which was derived from the glosopharyngeal nerve, terminated near the lateral part of the tongue base and the mucosa around the palatine tonsil after innervating the base of the palatine tonsil. Nonetheless, in all cases, the area innervated by the tonsillar branches of the glosopharyngeal nerve was confined to the tonsillar fossa and did not spread in an anterolateral direction by passing the palatoglossal arch.

Discussion

1. Sensory nerve distributing to the mucosa around the K-point

In all the present cases, several twigs of the lingual nerve, presumably the branches to the isthmus of fauces, innervated the mucosa near the palatoglossal arch, retromolar pad, and the lingual gingiva of the last molar. On the other hand, the tonsillar branches of the glosopharyngeal nerve were confined to the tonsillar fossa and do not spread anterolaterally beyond the palatoglossal arch. Therefore, the sensory nerves distributing to the area around the trigger point of jaw opening reflex were the branches of the lingual nerve, namely the branches to isthmus of fauces. This anatomical finding suggests that the nerves that trigger the jaw opening reflex are these branches. This interpretation should be verified by further studies, especially in a physiological methodology.

2. Triggering of the jaw opening reflex in patients with dysphasia

Thermal-tactile-stimulation (TTS) is known as a therapeutic technique for patients with dysphagia\(^1\)\(^2\). This method involves touching or rubbing the palatoglossal arch or anterior faucial pillar with a cold probe prior to the swallowing. Cold temperature and dynamic mechanical deformation are two primary stimulus components of the TTS. It is hypothesized that the touch and cold stimulation increases oral awareness and provides an alerting sensory stimulus to the cerebral cortex and brainstem. Therefore, when the patient initiates the oral phase of swallowing, the pharyngeal phase will be triggered more rapidly. In individuals with reduced oral sensation, a cold stimulus seems to facilitate more rapid pharyngeal swallow elicitation. However, over the years the precise mechanism of the effectiveness of TTS has been unclear.

According to Kojima et al.\(^3\), a series of reflexes from mouth opening to swallowing occur in patients with pseudobulbar palsy when the mucosa (K-point) near
Fig. 1. A; Photograph of the left lateral view of cranium. Arrow heads indicate the branches to the isthmus of fauces of lingual nerve. In this specimen, four branches to the isthmus of fauces are visible. B; Diagram of the branches of the lingual nerve. A quadrilateral frame indicates the observation area in this study. BN, buccal nerve; IAN, inferior alveolar nerve; LN, lingual nerve; MN, mylohyoid nerve; LC, labial commissure; SG, submandibular gland; MR, mental region.

Fig. 2. A; Photographic image of the branch to the isthmus of fauces. Arrow heads denote branching sites. Open circle denotes the jaw opening reflex triggering point. Photographed with a black rubber plate placed behind the nerve. B; Diagram of the branch to the isthmus of fauces shown in Figure A. Three or four branches are shown. C; Photograph of the branch to the isthmus of fauces. Arrow show the mylohyoid nerve. D; Diagram of the branch in Figure C. Six branching sites are shown. E; Photograph of the branch to the isthmus of fauces. Small branches form mesh networks with each other and innervate the mucosa of the palatoglossal arch, retromolar pad, and lingual gingiva of the last molar. F; Diagram of the branch to the isthmus of fauces shown in Figure E. Despite the complex morphology, there are only 3 branches. LN, lingual nerve; TP, triggering point; Scale bar = 10 mm.

Fig. 3. Diagram of the positional relationship between the faucial branches of the lingual nerve and neighboring nerves. TP, triggering point
the medial aspect of the most posterior region of the retromolar pad is stimulated on the affected side. In contrast, similar stimulation on the contralateral normal side provokes only a strange sensation, not the jaw opening. Although Kojima et al. did not explain its mechanism in detail, we consider the mouth opening and swallowing induced by stimulating the K-point as follows: The area around the K-point in normal individuals is regulated by a certain type of inhibitory neural mechanism. Because this area is subject to repeated mechanical and thermal force in usual mastication, some inhibitory system protecting the frequent reflexive opening of the mouth is assumed to exist. In patients with pseudobulbar palsy with damage to the corticobulbar tract, such inhibition is no longer effective, allowing a relatively subtle stimulus to trigger the jaw opening reflex. Consequently, the K-point simulation method seems to utilize an ineffectiveness of inhibitory mechanism on the jaw opening, being raised in pathological condition.

**Conclusion**

From an anatomical viewpoint, the nerve which induces the jaw opening reflex appears to be the branches of the lingual nerve, namely the branches to isthmus of fauces.

**Acknowledgment**

This research was supported by a Grant-in-Aid from the Ministry of Education, Culture, Sports, Science and Technology of Japan (No.24593484).

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Address for communication:
Dr. Shigemitsu Ogata
Professor, Faculty of Medicine, School of Health Sciences,
KAGOSHIMA UNIVERSITY,
8-35-1, Sakuragaoka,Kagoshima - 890 - 8544.
JAPAN
Telephone : 81 99 2756758
e-mail ID : sea-ogata@health.nop.kagoshima-u.ac.jp