The sensory nerves that innervate the area near the K-point

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Abstract

The purpose of this study clarified the sensory nerves that innervate the area near the trigger point of the jaw opening reflex. The trigger point is located at the midpoint between the palatoglossal arch and pterygomandibular fold and medial to the retromolar pad. For the morphological investigation of sensory innervation in this area, we exposed the cranial nerves in 52 halves of cadaver head and observed their distribution in soft tissue. In all the observed examples, the branches of the lingual nerve together formed mesh networks and distributed to the mucosa near the palatoglossal arch, retromolar pad, and the lingual gingiva of the last molar. It was suggested that 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. We believe that the information herein may be of use to substantial nursing care and dysphagia rehabilitation.

Key words
morphology, dysphagia, pseudobulbar palsy, lingual nerve, jaw opening reflex, K-point

1. Introduction

At present, advanced nations face the issues of population decrease and a super-aging society. In Japan, the proportion of residents aged 65 years and older is 25.1% of the population. By 2030, the proportion is estimated to reach 31.6%, with one in three of the total population being elderly (Statistics Bureau 2014). Because of the rapid aging of society, with many residents who held dysphagia, demands for quality medical and nursing care will continue to increase. Dysphagia due to stroke is caused by damage to the brain region that regulates deglutition. The deglutition center is located in the medulla oblongata. While dysfunction of this center causes bulbar palsy, dysphagia in patients with pseudobulbar palsy is due to damage to the brainstem superior to the medulla oblongata or cerebrum (Martin and Sessle 1993). The deglutition reflex is less likely to occur or occurs insufficiently in patients with bulbar palsy. But then, in patients with pseudobulbar palsy, despite initial difficulty, once the deglutition reflex is initiated, a series of movements follow smoothly (Rogus-Pulia and Robbins 2013).

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 (Nishi et al 1985, Ohkawa et al 1997, Sherrington 1917, Woodworth and Sherrington 1904). The jaw opening reflex is sometimes triggered by lightly pressing the mucosa near the aspect of the retromolar pad (Suazo et al 2007) with a tongue depressor or a finger (Figure 1). Kojima 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 (Kojima et al 2002).

The trigger point is located midpoint between the palatoglossal arch and pterygomandibular fold and the medial aspect of the retromolar

pad. However, previous reports are unclear or inconsistent on this point (Fitzgerald and Law 1958, Scheiderbauer et al 2001, Tier et al 1984, Weinberger et al 1994, Yamamoto 1975, Zur et al 2004). Therefore, in this study, we carefully investigated the sensory nerves that innervate the area near the trigger point of the jaw opening reflex. We believe that the information herein may be of use to substantial nursing care and dysphagia rehabilitation.

2. Method

We examined the lingual nerves, with their associated structures, from Japanese cadavers (52 halves of 26 individuals, 12 males and 14 females, aged from 56 to 84 years old, 68.7 years on the average) from the student dissection course at Kagoshima University Faculty of Dentistry in 2012-2013. By removing the digastric, mylohyoid, and geniohyoid muscles, the hypoglossal nerve which runs over the hyoglossus muscle and the lingual nerve which runs laterally to the styloglossus muscle were exposed.

To prevent accidental cutting of small nerve fibers, dissection of the area 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).

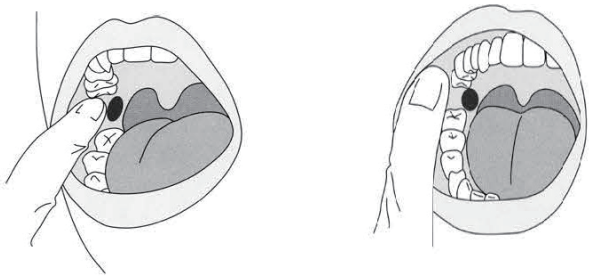

Figure 1. K-point stimulation. The jaw opening reflex is triggered by lightly pressing the mucosa near the aspect of the retromolar pad with a finger. Solid circle denotes the jaw opening reflex triggering point (K-point).

3. Results

The estimated nerves that innervate the K-point area were the tonsillar branches of the glossopharyngeal nerve, and the branch of the lingual nerve, which is a branch of the mandibular nerve. The tonsillar branches of the lingual branches, which were derived from the glossopharyngeal nerve, terminated near the lateral part of the tongue base and the mucosa around the palatal tonsil. For all that, the area innervated by the tonsillar branches of the glossopharyngeal nerve was confined to the tonsillar 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. 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 through the area superior to the deep part of the submandibular gland. In the sublingual area, the lingual nerve gave off the ganglionic, communicating and terminal branches (Figure 2).

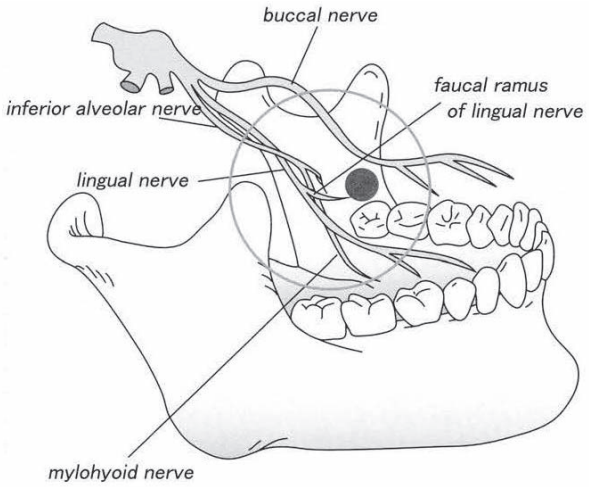

Figure 2. Diagram of the positional relationship between the faucial branches of the lingual nerve and neighboring nerves. Solid circle denotes the jaw opening reflex triggering point (K-point).

In all the observed examples, several twigs 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. 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 (Figure 3).

4. Discussion

There are many things which are not solved about K-point. For example, it is the facilitative effect of thermal-tactile-stimulation (TTS) to the K-point area on swallowing reflex. TTS is known as a therapeutic technique for patients with dysphagia (Logemann 1995, Power et al 2006, Tachimura et al 2006). And the effectiveness of TTS as a therapeutic method is supported. This method involves touching or rubbing the palatoglossal arch or anterior faucial pillar. Cold temperature and dynamic mechanical deformation are two primary stimulus components of the TTS (Sciortino et al 2003). It is hypothesized that the touch and cold stimulation increases oral awareness and provides an alerting sensory stimulus to the cerebral cortex and brainstem (Chi-Fishman et al 1994). So, when the patient initiates the oral phase of swallowing, the pharyngeal phase will be triggered more rapidly. The branches of the glossopharyngeal nerve distribute the anterior faucial pillars which is the stimulated region of TTS. As a result, the glossopharyngeal nerve did not spread in an anterolateral direction by passing the palatoglossal arch. In the morphological aspect, it is important to distinguish the region of TTS and the K-point area. Anatomically, several twigs of the lingual nerve innervated the mucosa near the palatoglossal arch and retromolar pad. But the tonsillar branches of the glossopharyngeal nerve were confined (Figure 4). Morphologically, the sensory nerves distributing to the area around the K-point were the branches of the lingual nerve. This anatomical finding suggests that the

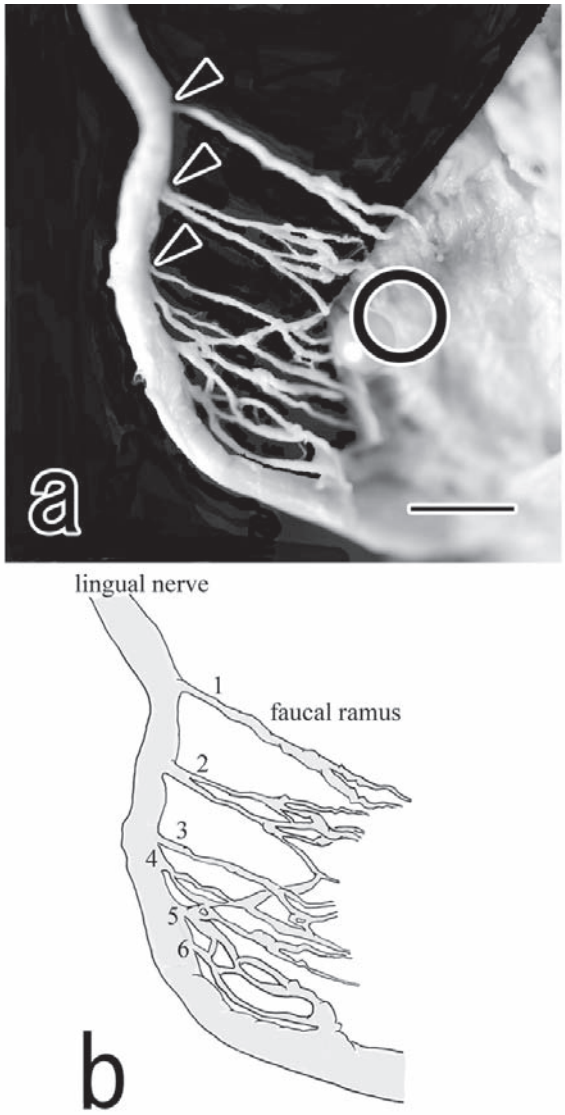

Figure 3. a; Photographic image of the branch to the isthmus of fauces. Arrow heads denote branching sites. Open circle denotes the jaw opening reflex triggering point. Photographed with a black rubber plate placed behind the nerve. Scale bar = 10 mm. b; Diagram of the branch in Left figure (a). Six branching sites are shown.

nerves that trigger the jaw opening reflex are these branches.

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 (Leopold

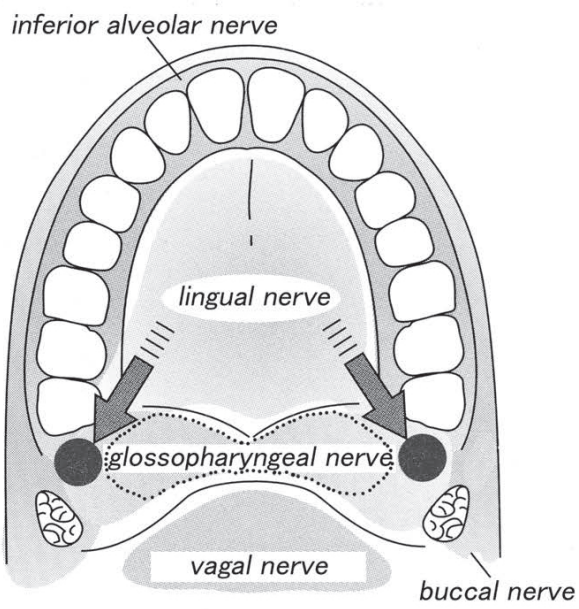

Figure 4. Nerve innervation in the mandibular mucosa. The area innervated by the tonsillar branches of the glossopharyngeal nerve is confined to the tonsillar fossa. Solid circle denotes the jaw opening reflex triggering point (K-point).

and Daniels 2010). 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 (Kaatzke-McDonald et al 1996). According to Kojima, a series of reflexes from mouth opening to swallowing occur in patients with pseudobulbar palsy when the mucosa near 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 (Kojima et al 2002). Although Kojima 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. As 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. The limitation of the study is that this interpretation should be verified by further studies, especially in a physiological methodology.

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