Topographical relationship between positions of lingual foramina and attachment of mylohyoid muscle in mental region

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オトガイ部における舌孔の出現部位と顎舌骨筋との位置関係

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Abstract

Purpose

Lingual foramina can be observed between the lingual aspects of the mandible in humans. A sublingual artery is thought to exist in sublingual space and a submental artery in submaxillary space, which pierce the mandible through lingual foramina. During surgery for oral implant placement between apices of the mental foramen, it is important to determine the existence and positioning of lingual foramina. The purpose of this study was to investigate the positions of lingual foramina in relation to the mylohyoid muscle and vertical position of the mylohyoid line using CBCT images.

Materials and Methods

We examined 20 formalin-perfused cadavers. The mylohyoid muscle was dissected and marked with a silicone tube, then CBCT images were obtained to evaluate the relationship of that muscle with lingual foramina.

Results

We observed 37 lingual foramina in the 20 cadavers. As for vertical positioning, 16 lingual foramina were found in sublingual space, while in horizontal positioning, 6 were found in the anterior region of sublingual space. The ratio of vertical distance from the inferior margin to the mylohyoid line and mental spine was lower in the anterior region as compared to the posterior region.

Conclusion

In the present study, lingual foramina were found to commonly exist in sublingual space above the mylohyoid muscle and pierce the mesial side. For evaluation of the vertical position of the mylohyoid line, it is

better to use the stable mental spine rather than the alveolar process.

Key words

lingual foramen, submaxillary space, sublingual space, CBCT

和文抄録

緒　言

舌孔の有無が下顎に対する外科的処置後の内出血に関連している場合がある。過去に舌孔に関しての研究は行われているが，出血の要因と考えられる周囲の軟組織との関係についての報告はなく，実際の舌孔出現部位を特定できる研究はほとんどない。そこで,顎舌骨筋に着目し，付着部に対する垂直的・水平的位置関係で把握することにより，舌孔の出現部位と周囲軟組織との関連について検討を行った。

材料および方法

奥羽大学倫理審査委員会の承認（承認番号105号）を得た後，奥羽大学実習用遺体 20 体において顎舌骨筋を剖出し，下顎骨への付着部にマーキングしたのちに，歯科用 CBCT を撮影した。得られた画像データから舌孔の出現部位と顎舌骨筋付着部を観察した。顎舌骨筋線を垂直的基準とし，上方を舌下隙，下方を顎下隙に分類した。さらに，顎舌骨筋線の垂直的位置の把握のため，正中部におけるオトガイ棘と下顎下縁の距離と，各部における顎舌骨筋付着部と下顎下縁の距離を計測し，その比率を求めた。近遠心的基準として，オトガイ棘外側縁とオトガイ孔前縁の間を 2 等分し，オトガイ棘側およびオトガイ孔側として，舌孔の出現部位を分類した。

結　果

観察された舌孔の全数は 37 個であり，舌下隙 16 個中オトガイ棘側で 6 個（37.5%）,オトガイ孔側で 10 個（62.5%）であり，顎下隙 21 個中，オトガイ棘

側で1個（4.8%），オトガイ孔側で20個（95.2%）であった。顎舌骨筋線の垂直的位置関係は，オトガイ棘外側縁では，ほぼ中央 51.9±17.1%であるのに対し，オトガイ孔前縁では上方 79.2±21.4%に位置し，それらの中央部ではほぼ中間の高さ 66.6±20.0%であった。

考　察

本研究では，オトガイ棘側では舌下隙，オトガイ孔側では顎下隙に舌孔が多く開口していた。顎舌骨筋線の垂直的位置は，正中付近では下顎下縁からオトガイ棘までの距離の中央に位置し，小臼歯部ではより上方に存在していたことから，歯の喪失に伴う形態変化の影響が少ないオトガイ棘をランドマークとした顎舌骨筋線の垂直的位置の推測が，顎骨手術に伴う術後の内出血の術前診断に有用であると考えられる。

キーワード

舌孔，顎下隙，舌下隙，　CBCT

Introduction

In previous reports, the anterior region of the mandible between each side of the mental foramen has been promoted as a location for safe placement of implants. However, recent reports have noted hemorrhaging during implant placement in the anterior tooth region of the mandible[1~3], with the anatomical structure of the region between apices of the mental foramen in the mandible a likely cause. The space below the mylohyoid muscle is termed submaxillary space and contains the submental artery after branching off from the facial artery, while the space above the mylohyoid muscle is termed sublingual space and contains the sublingual artery after branching off from the lingual artery[4]. During placement of an implant, perforation of the lingual cortical bone will cause injury to these arteries and hemorrhaging in the region. Development of a large hematoma was reported in a case in which lingual perforation was not noticed prior to the procedure[1].

A midline lingual foramen exists at the midline of the mandible and superior to the mental spine, which contains branches of the sublingual artery. In addition, another medial lingual foramen exists inferior to the mental spine and contains branches of the submental artery[5]. It is thought that bleeding in submaxillary space is caused by subcutaneous hemorrhaging. On the other hand, hemorrhage in sublingual space above the mylohyoid muscle may cause swelling of the sublingual region and respiratory distress. Perforation of the cortical bone in the lingual aspect of the mandible can lead to hemorrhaging and swelling, causing severe patient anxiety because of respiratory distress[1,3]. A previous study reported an active bleeding source located 4 cm posterior of the mandible following lingual cortical bone perforation during an implant placement procedure in the anterior region of the mandible[2]. Moreover, another noted that a large hematoma and severe swelling of submandibular region occurred after implant placement

because of a lingual perforation that was not noticed prior to performing the procedure[1]. In the present study, we used CBCT imaging to investigate the positioning of lingual foramina that connect with the mylohyoid muscle and the vertical position of the mylohyoid muscle attached to the mandible.

Materials and methods

Twenty formalin-perfused cadavers provided with ethical approval from the Department Ethics Committee of Ohu University were examined (10 females, 10 males, average age 84.4 years), of which none had surgical scars or gross anatomical abnormalities. Following dissection of the mylohyoid muscle (Fig. 1), a silicone line (Washiesu Medical, Silicone line white, Japan) was placed the point of its attachment to the mandible (Fig. 2). CBCT images were obtained using a CBCT(3DX Multi Image Micro CT, Morita, Japan), with scanning performed for 18 seconds at 80 kV and 5 mA. Obtained images were reconstructed with the mandibular plane parallel to the horizontal plane. Such reconstructed images of the anterior mandibular region were confirmed under the preferred conditions of the attending oral surgeons to evaluate the lingual foramen. All images were evaluated by 2 oral surgery guidance physicians with agreement reached by consensus. In each reconstructed CBCT image, the plane parallel to the mandibular plane including the mental spine was set as plane A and that parallel to the mandibular plane including the superior margin of the silicone line as plane B, while the mandibular plane was set as plane C (Fig. 2).

We set the two vertical planes to plane C, tangent to the mandibular lateral surface on the posterior edge of the mental spine and anterior edge of the mental foramen. The plane including the posterior edge of the mental spine was regarded as plane ① and the other as plane ③, with the midpoint of those set as plane ② (Fig. 3). Moreover, the

anterior and posterior regions were classified into two vertical regions according to plane B. Inside of the mandible, the inferior region of plane B was considered to be submaxillary space and the superior region sublingual space. Finally, the region of interest for measuring an apparent lingual foramen was subdivided into four regions; anterior submaxillary, anterior sublingual, posterior submaxillary, and posterior sublingual space. As a result, an observed lingual foramen was evaluated in four regions. Subsequently, to assess the vertical position of the mylohyoid muscle attached to the mandible in each reference plane used for horizontal measurement, we determined the vertical distance between plane C and plane B. The ratios of the vertical distance between plane C and plane B in each region to the vertical distance between plane C and plane A in the region of the midline of the mandible were then calculated.

Results

A total of 37 lingual foramina were found in 17 of the 20 cadavers examined in this study. In the vertical position, 16 lingual foramina were found in sublingual space above the mylohyoid muscle attached to the mandible and 21 in submaxillary space below the mylohyoid muscle. Horizontally, 6 were located in the anterior region (between plane ① and plane ②) of sublingual space and 10 were located in the posterior region (between plane ② and plane ③). In submaxillary space, there was 1 lingual foramen in the anterior region and 20 in the posterior region (Table 1).

The vertical distance between the point where the mylohyoid muscle attached to the mandible and inferior margin of the mandible was 5.5±1.4 mm at the posterior margin of the mental spine, 8.5±1.9 mm at the anterior margin of the mental foramen, and 7.1±1.7 mm at the midway point. The ratios after dividing those vertical distance

measurements by the vertical distance between the mental spine and inferior margin of the mandible in the midline were 51.9 ± 17.1%, 79.2 ± 21.4%, and 66.6 ± 20.0%, respectively (Table 2).

Discussion

Hemorrhaging can occur during dental implant placement in the region of the anterior mandible[1,3]. Some reports have noted that an active bleeding source was found up to 4 cm away from the mandible[2] and that hemorrhaging occurred because a perforation was not noticed prior to the procedure[1]. In a previous observational study that utilized dental CT images obtained from 32 patients, at least 1 lingual canal was found in each patient. Lingual foramina can appear in 2 different locations, the median lingual canal and lateral lingual canal, with a reported frequency in the median lingual canal of 98%, and that of 34% and 38% on the left and right side, respectively, of the lateral lingual canal[6]. That study defined lingual canals as consisting of two types, those that exist on the inner surface of the mandible, and those found in the median lingual canal near the midline and lateral lingual canal in the premolar region. A topographical study of lingual foramina performed using micro-CT revealed their existence. Vertically, a lingual foramen can be divided into two types, superior and inferior, according to the position relative to the mental spine. Horizontally, lateral lingual foramina have been found between the lateral incisor and canine in the mandibular lingual aspect[7]. In the present study, the mesial margin of the region of interest was set at the lateral side of the mental spine. Thus, the portion termed median lingual foramen in other studies was not included in our results. In Choi's study[7], a superior lingual foramen was detected in all examined specimens. Moreover, another report noted that midline foramina were detected in 95.2% of examined mandibles[8]. In our study, the mental spine was not included

in the region of interest. We detected a lingual foramen between the lateral end of the mental spine and midway point of the mental spine to mental foramen in sublingual space in 7 of 40 sides examined.

Because of the low reliability of images obtained with CBCT, window level and image width have not been standardized[9]. Therefore, in the present study, all images were confirmed using preferred conditions and all lingual foramina observed were evaluated by two oral surgeons, each with several years of experience, with agreement reached by consensus.

In the anterior portion of the mandibular body, the space above the mylohyoid muscle is termed sublingual space and that below submaxillary space[4]. Both the lingual and facial arteries originate from the external carotid artery, while the sublingual artery arises from the lingual artery, and runs forward between the mylohyoid and genioglossus muscles. As for the submental artery, it originates from the facial artery and runs forward beneath the chin[4]. The sublingual artery is sometimes an insignificant branch of the lingual artery and may even be missing. When missing, that is replaced by a branch of the submental artery, which itself is a branch of the facial artery. There are cases in which the lingual and facial arteries originate independently from the external carotid artery, while branches existing above and beneath the mylohyoid muscle were reported to be observed in 42% of investigated cases[10]. In a gross anatomical study, the sublingual artery was found to originate from the lingual artery in 73% of examined cases, while that in the remaining 27% originated from the submental artery, with anastomosis found in 40% of these arteries. Perforating branches of an artery passing through the middle lingual canal were identified in 98% of examined specimens of another study[11]. In the present study, some of the lingual foramina found in sublingual space had pierced the mesial side.

The Pirogoff triangle, which is composed of the hypoglossal nerve, intermediate tendon of the digastric muscle, and posterior margin of the mylohyoid muscle, always contains the lingual artery and is found within the submandibular triangle. To control severe hemorrhaging in the oral cavity, the Pirogoff triangle is an ideal site for ligation of the lingual artery to identify the origination of bleeding[12]. When a genial spinal foramen is dissected, branches of the lingual artery enter the superior genial foramen[7]. In contrast, nearly half of the sublingual arteries contain constituents of the facial artery. A previous study found mylohyoid muscle defects in 4 of 6 heads investigated as well as submental arteries piercing the mylohyoid muscle in 34% of all sides examined[10]. In a study that performed anatomical dissection of the oral floor, 52.6% of the specimens showed a small, insignificant, or missing sublingual artery, while a perforating branch of the submental artery was found passing through the mylohyoid muscle in all cases. Accordingly, when recalcitrant intraoral bleeding is encountered, it is necessary to first ligate the facial artery. If that fails to stop the bleeding, then it will be necessary to ligate the lingual artery[13].

The mylohyoid line extends diagonally downward and forward on the inside of the mandibular body. In cases in which it is well developed, it passes between the mental spine and digastric fossa, and reaches to the lower border of the mandible[14]. In our study, the vertical position of the mylohyoid line was found to ascend accordingly and run in a posterior direction, while the mental spine was noted to exist above the anterior end of the mylohyoid line. On the external surface of the mandibular body, the mental foramen lies between the premolar teeth[15]. Thus, the mylohyoid line around the mental foramen is lower than the vertical position of the mental spine. To evaluate the vertical position of the mylohyoid line, it is useful to use the stable mental spine rather than the alveolar process, which changes shape in association with

tooth loss.

Compliance with ethical standards

Conflicts of interest: None to declare.

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Figure legends

Fig. 1

Images of dissected lingual foramen observed from inferior aspect and CBCT images.
Arrowhead indicates the neurovascular bundle running into the lingual foramen.
Arrow indicates lingual foramen in CBCT image.

Fig. 2

Reference plane for measurement of vertical distance.

A. Including mental spine.

B. Including superior margin of silicone line.

C. Including inferior margin of mandible.

Fig. 3

Reference plane for horizontal measurement

① Including posterior edge of mental spine.

② Including midway point between plane ① and plane ③.

③ Including anterior edge of mental foramen.

Table. 1

Number and areas of lingual foramina

Table. 2

Vertical position of attached part of mylohyoid muscle

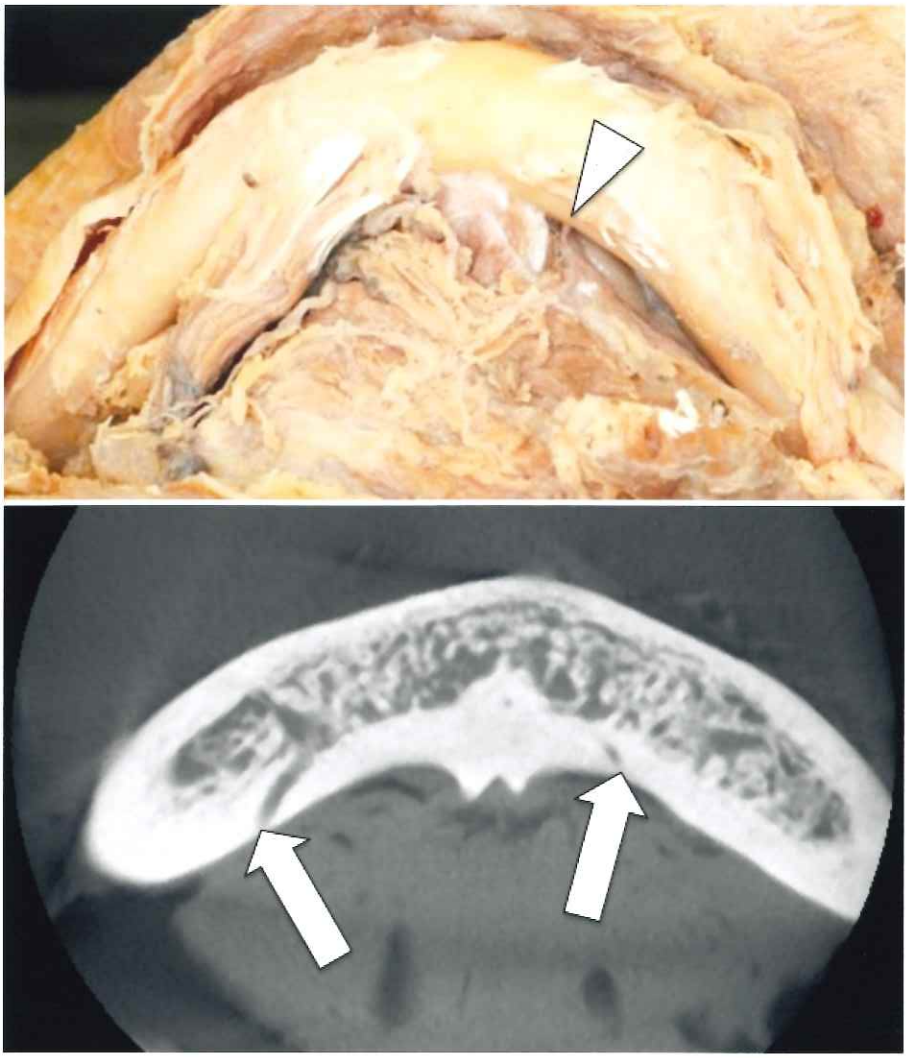

Fig.1

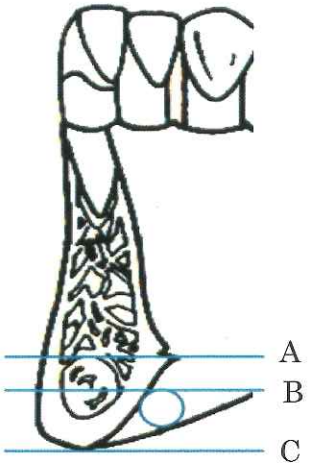

Fig.2

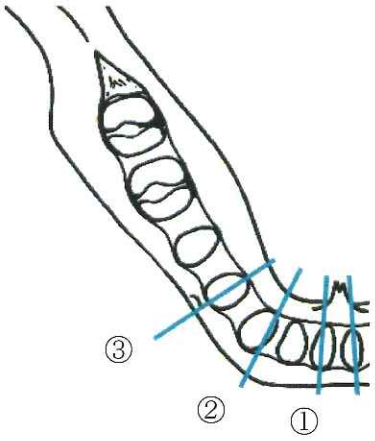

Fig.3

Table.1

	Sublingual spaces		Submaxillary spaces	
	①-②	②-③	①-②	②-③
Number of lingual foramina	6	10	1	20
Total	16		21	
Areas showing a lingual foramen	5	10	1	18
Frequency (%)	12.5	25	2.5	45

Table. 2

Vertical distance from inferior margin of the mandible(mm)	Mean	S.D.
Midline(AC)	10.9	1.3
Posterior margin of the mental spine(BC)	5.5	1.4
Midway point (BC)	7.1	1.7
Anterior margin of the mental foramen(BC)	8.5	1.9

AC: vertical distance from mental spine to inferior margin of the mandible.

BC: vertical distance between the superior margin of silicone tube and attachment point of mylohyoid muscle to mandible and inferior margin of mandible.

Ratio of vertical distance from mylohyoid muscle attachment point to mandible (BC) to mental spine (AC) along midline (%)	Mean	S.D.
Posterior margin of mental spine(BC)	51.9	17.1
Midway point (BC)	66.6	20.0
Anterior margin of mental foramen(BC)	79.2	21.4

AC: vertical distance from mental spine to inferior margin of mandible.

BC: vertical distance between superior margin of silicone tube, attachment point of mylohyoid muscle to mandible and inferior margin of mandible.