Macroanatomic and Radiologic Characteristics of the Superior Genial Spinal Foramen and Its Bony Canal

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Purpose: *To determine the incidence, size, location, course, and content of the superior genial spinal foramen and its bony canal.* ***Materials and Methods:*** *Three hundred eighty dry human cadaver mandibles were morphometrically analyzed by measuring the distance from the foramen to the mandibular base and the size of the foramen and bony canal. Radiologically, the course of the bony canal and its relation to the mandibular incisive canal were investigated after injecting contrast medium (Omnipaque) in the superior genial spinal foramen and the incisive canal at the level of the mental foramen or by inserting a thin metal wire into the bony canal. Dissection was performed on another 10 intact cadaver mandibles.* ***Results:*** *A distinct foramen was present in 98% of all dry specimens studied. Its general form was round or flattened funnel-shaped. Upon microanatomic dissection, a distinct branch of the lingual artery and the lingual nerve entering the superior genial spinal foramen were found.* ***Conclusions:*** *The superior genial spinal foramen is present in most human mandibles and appears to be the entrance of a true lingual neurovascular bundle passing into the bone via a well-defined bony canal toward the buccal side. This implies that surgery and more specifically implant placement at the mandibular midline may carry some risk of neurovascular damage.* (Basic Science) INT J ORAL MAXILLOFAC IMPLANTS 2006;21:581–586

Key words: *dental implants, lingual foramen, macroanatomy, mandible neurovascularization*

The increasing use of oral implant treatment to rehabilitate the edentulous jawbone has brought about a number of reports on potential complications related to implant placement,[1–4] such as hemorrhaging and neurosensory disturbances. This may explain the increased interest in the anatomy of the anterior mandible. Thompson[5] called the lingual foramina the supraspinous foramen, interspinous foramen, and infraspinous foramen. To distinguish the foramen at the lingual aspect of the midline of the mandible, Vandewalle and colleagues[6] called it the superior genial spinal foramen.

Previous research on the lingual foramina has generated variable results regarding their locations, incidence, appearance, and neurovascular content. Shiller and Wiswell[7] found a median lingual foramen in 89% of 126 specimens in the mid-1950s. Reports in the following decades have described incidences of 87% to 99% of human mandibular specimens examined.[8–10]

Considering visualization on radiographic projections, Poyton and Pharoah[11] reported that the foramen was seen in only a small percentage of radiographs of the incisor region. However, McDonnell and colleagues[9] reported visualization on 49% of radiographs, which is higher than the 28% reported by Sweet[12] and the low percentage suggested by Poyton and Pharoah.[11] However, reported radiographic visualization is still much lower than the actual incidence of the foramen reported in anatomic studies.[7–10]

Besides the foramen and canal characteristics, it is essential to know the canal content. From a literature review, it seems that the true content remains a matter of debate. Ennis[13] stated that the lingual foramen transmits a branch of the incisive artery to anasto-

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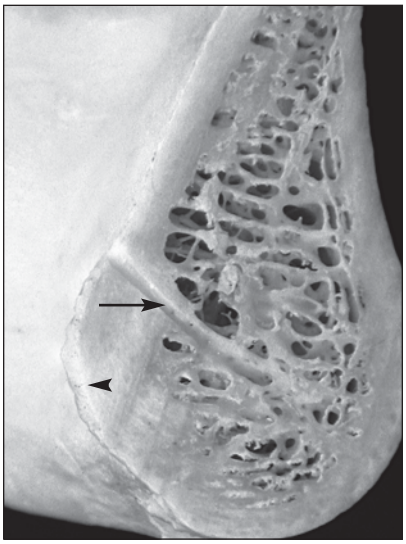


Fig 1 Macroanatomic illustration of a single canal *(arrow)* located superior to the genial spine *(arrowhead)* in the mandibular midline.

mose with the sublingual artery. A branch of the sublingual artery was reported by Suzuki and Sakai,[10] McDonnell and colleagues,[9] and Hofschneider and associates.[14] Novitsky[15] demonstrated by blunt dissection the passage of branches of the mylohyoid nerve through a foramen inferior to the genial spines. Later, Sutton[8] reported that branches of the mylohyoid nerve and vessels were present in the foramen. Finally, Percinoto and associates[16] and Madeira and coworkers[17] reported that the canal content was neurovascular, with branches of the mylohyoid nerve and sublingual artery.

Based on the contradictory information of the mandibular midline canals and the potential implications of damage in this region, the present study aimed to carefully assess the superior genial spinal foramen, which is on or superior to the genial spine in the midline. The objective was to characterize this structure from a macroanatomical and radiologic point of view in order to objectively define the incidence, size, location, course, and content of this foramen and its bony canal.

MATERIALS AND METHODS

A total of 390 Indian human cadavers were used for the present investigation. The mandibular specimens were derived from patients who had donated their bodies for research and were provided with ethical approval by the department of morphology (University Centre Limburg [LUC], Diepenbeek, Belgium).

Macroanatomical Assessment

Three hundred fifty-four dry mandibles were morphometrically analyzed by measuring the location of the superior genial spinal foramen (ie, its distance from the mandibular base) and the size of the foramen at the entrance of the bony canal. Final sets of 26 additional hemimandibles were analyzed. The diameter and length of the bony canal was measured after bone preparation.

Radiographic Assessment

The course of the bony canal and its relation to the mandibular incisive canal were investigated by injecting a contrast medium (Omnipaque, Amersham, UK). Contact radiographs of 188 intact mandibles from the aforementioned set of 354 dry mandibles were reviewed to assess the presence of the connection of the right and left incisive canals. The incidence of such midline connection was noted. Radiography was performed using a low-pulse x-ray apparatus (40 kV, 7 mA, 0.01 second; Agfa, Mortsel, Belgium) in the superior genial spinal foramen or by inserting a metal wire into the bony canal.

Dissection

Another study was performed on the 10 remaining intact mandibular specimens. These were dissected to macro- and microanatomically investigate the canal contents associated with the foramen.

RESULTS

Macroanatomic Assessment

A distinct foramen was present at or just superior to the genial spines in 347 of 354 dry specimens studied (98%). Its general form was round or flattened funnel-shaped, depending on its location above or at the superior genial spines (Fig 1). The foramen was located an average of 10.6 mm (SD 1.6 mm) above the inferior mandibular border (range, 6.0 to 15.4 mm). The average size of the foramen, measured at the entrance of the bony canal, is given in Table 1 (see also Figs 2 and 3).

Radiologic Assessment

A metal wire was inserted into the lingual side of the canal during radiography to show the course of the canal (Fig 4). This also allowed the length of the canal into the mandible and the direction of the canal to be viewed. When contrast medium was injected into the superior genial spinal foramen, a connection was visualized in 77 of 186 radiographs (41%) (Fig 5).

Table 1 Dimensional Characteristics of the Foramen and Bony Canal

	n	Mean (SD) (mm)	Range (mm)
Foramen			
Diameter (short axis)	354	0.6 (0.2)	0.1 to 1.1
Diameter (long axis)	354	0.7 (0.2)	0.2 to 1.5
Height	354	10.6 (1.6)	6.0 to 15.4
Bony canal			
Diameter at its midpoint	26	0.6 (0.21)	0.3 to 1.0
Length	26	6.2 (1.5)	4.4 to 10.4

The foramen was found in 347 specimens, for an incidence of 97.7%.

Fig 2 *(Left)* Stereomicroscopic image showing a midline foramen with a single canal.

Fig 3 *(Right)* Stereomicroscopic image of a foramen branching into 2 canals.

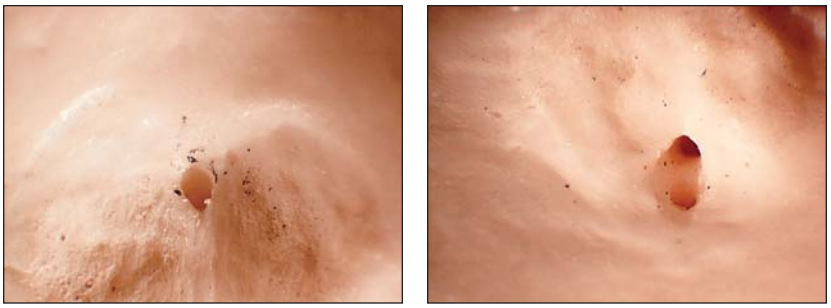
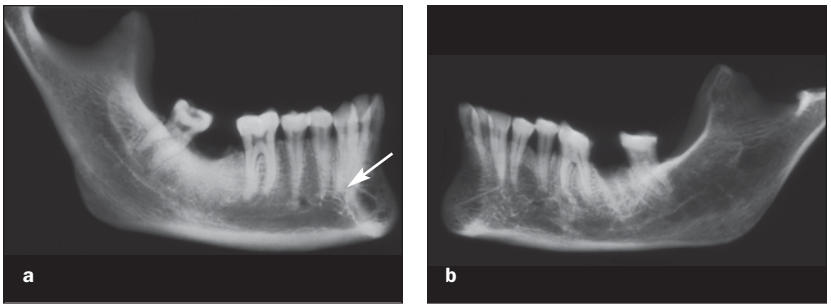


Fig 4 Two contact radiographs of *(a)* the right and *(b)* the left sides of a mandible showing a wire in the canal *(arrow)*.



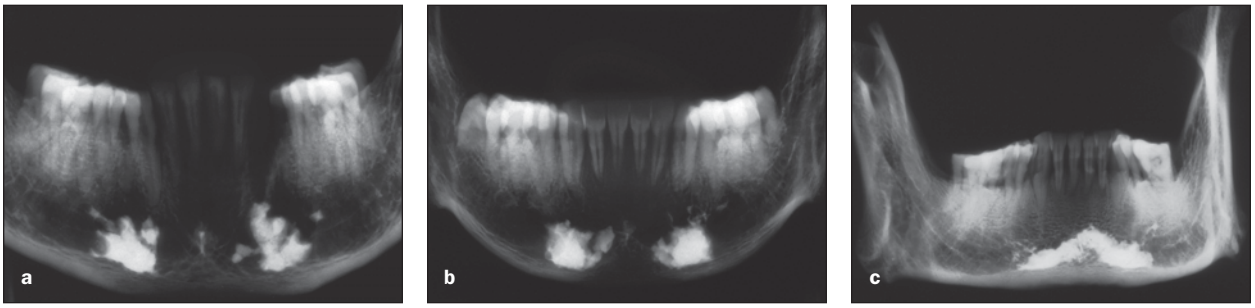


Fig 5 Contrast medium was injected in the superior genial spinal foramen to demonstrate the relationship between the foramen and the incisive canal. A connection between the incisive canals in the mandibular midline cannot be seen in *a* or *b*; *c* shows a connection between the left and right incisive canals in the region of the superior genial spinal foramen.

Dissection

Finally, the canal content was observed by dissection of 10 intact cadaver mandibles. A branch of lingual artery and lingual nerve entering the superior genial spinal foramen was found by dissection (Figs 6 and 7).

DISCUSSION

In the present study, a superior genial spinal foramen was present in 98% of the mandibles studied. This is in agreement with the reports of McDonnell and

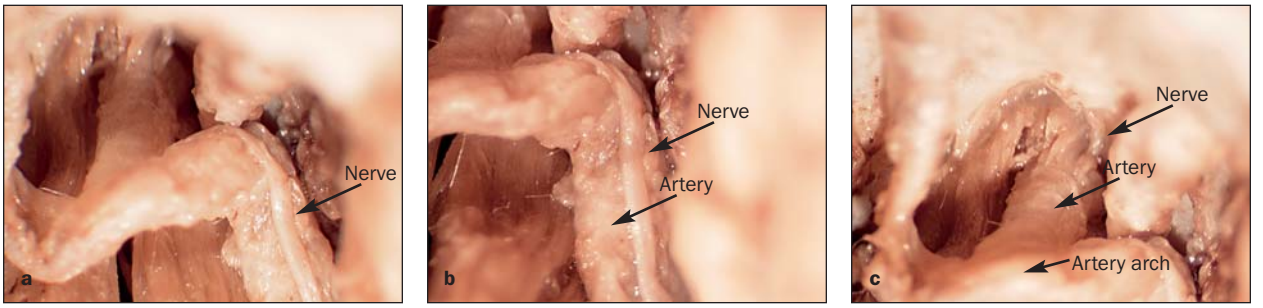


Fig 6 Dissection of the floor of the mouth. The lingual artery and lingual nerve can be observed entering the superior genial spinal foramen. In *a* and *b*, the lingual nerve appears to follow the branch of the lingual artery. In *c*, the lingual nerve and lingual artery enter the superior genial spinal foramen.

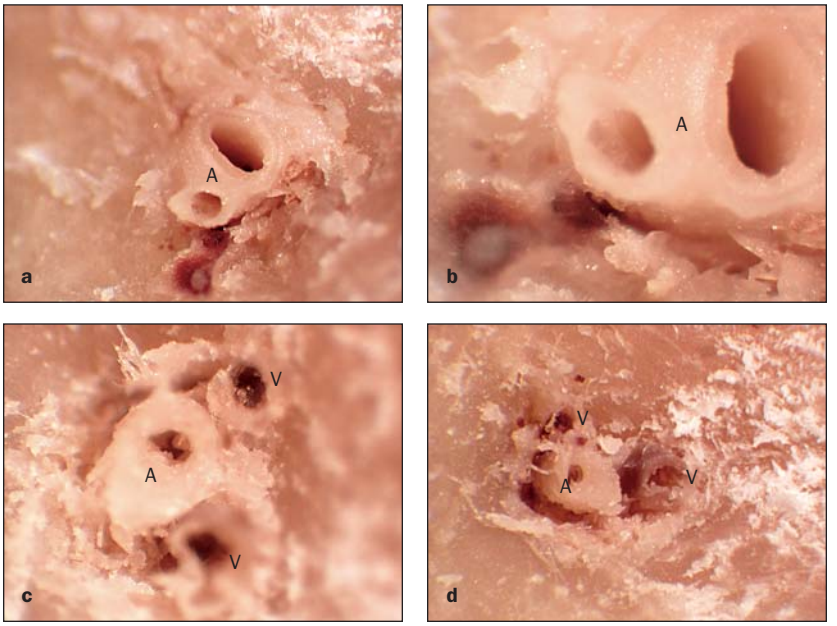


Fig 7 Photographs of the middle part of the mandible showing a branching blood vessel entering the foramen (A = artery, V = vein). Parts *a* and *b* show 2 branches of the artery entering the foramen. Parts *c* and *d* show 1 branch of the artery and 2 branches of the vein entering the foramen.

associates (99%).[9] This finding demonstrates that this anatomic feature should be considered during surgery in the mandibular midline to avoid potential complications.

Indistinct and contradictory descriptions of superior genial spinal foramen have been reported in the literature (Table 2).[3,5–9,11,13,18–21] However, the clinical relevance of this anatomic feature is underscored by the increasing number of implant operations at the mandibular midline and reports of complications following such operations.[4,22]

Although the superior genial spinal foramen has been found in a high percentage of anatomic studies, investigators[9,11] have had difficulty locating it on conventional radiographs of the midline region. McDonnell and colleagues[9] emphasized that the lingual canal has an inclined path in relation to the lingual surface of the mandible. When the radiographic tube is not oriented parallel to the long axis of the canal, the radiograph will fail to show it. This may explain the difficulties of radiologic depiction of the bony canal.

Contrast medium was used to visualize a relationship between left and right incisive canals on the mandibular midline of 41.4% of the mandibles. This cross-innovation and cross-visualization may have some clinical implications during surgery in this region. However, the use of contrast media in dry mandibles may not be ideal, since diffusion outside canals cannot be completely avoided.

The present study evaluated 390 mandibles of Indian origin. It is possible that ethnic differences may include variations in anatomy.[23] However, no differences in incidence of the superior genial spinal foramen between races have been demonstrated. It could be interesting to repeat this study with mandibles from people of other races. The same reasoning applies to the potential for differences between genders.[23] It was not possible with the present material to study the differences between gen-

Table 2 Overview of the Terminology Used in Different Historical Periods and Various Reports

Name of the foramen	Author	Year
Trou mentonnier median	Bertelli[18]	1892
Trou et canaliculaire susgénien	Dubreuil-Chambardel[19]	1906
Supraspinous foramen		
Interspinous foramen		
Infraspinous foramen	Thompson[5]	1916
Lingual foramen of the mandible	Ennis[13]	1937
Central pit	Ingram[20]	1950
Median lingual foramen	Shiller and Wiswell[7]	1954
Unnamed foramen	Worth[21]	1963
Midline foramen	Sutton[8]	1974
Midline pit	Poyton and Pharoah[11]	1989
Mandibular lingual foramen	McDonnell et al[9]	1994
Bone canals in the mandibular interforaminal region	Tepper et al[3]	2001
Superior genial spinal foramen and its bony canal	Vandewalle et al[6]	2003

ders, although anatomic differences between male and female might occur.

A number of researchers have supposed, based on histologic examinations, that the blood vessels and nerves may enter these midline foramina. This has also been confirmed by dissection of the middle part of the mandible (Fig 7). Most of the researchers reported blood vessels, but few identified nerves with fine dissection. In the present study, microanatomic dissection showed a branch of both the lingual artery and the lingual nerve entering the superior genial spinal foramen. So far, this has not been reported in the literature to date. Only Ennis[13] described a terminal branch of the inferior alveolar artery passing through the lingual foramen to anastomose with the lingual artery. The findings of the present study may differ from previously reported anatomic studies because it included fine microanatomic dissection of 10 cadavers, whereas the number of mandibles dissected and the nature of the dissections may have been more limited in past reports. Contradictory reports may also be related to the fact that the inferior foramen located below the floor of the mouth may have been the foramen under consideration in some cases. Most of the researchers did not specify whether they were investigating the superior or inferior foramen.

The artery that was found in the canal is of sufficient size to cause severe hemorrhaging during oral surgery. In 1 review, Kalpidis and Setayesh[24] reported that this foramen is 1 of the anatomic considerations related to hemorrhage. Heavy hemorrhage may increase the likelihood of life-threatening incidents. Neurosensory disturbances also regularly occur in this region after implant surgery.[25]

CONCLUSION

The superior genial spinal foramen was present in most of the mandibles studied (98%). The identification of a true neurovascular bundle of lingual arterial and nervous origin in the bony canal may carry some potential risks in implant placement or any other surgical procedures at the mandibular midline.

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