



A comprehensive review of the mental spine

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Abstract: Clinical case reports and research regarding the mental spines and their associated structures create a detailed picture of the floor of the mouth for assessment during clinical treatment. This compilation of information covers the mental spines, the attached geniohyoid and genioglossus muscles, the lingual foramina, and the veins and arteries of the jaw and floor of the mouth. It is important to consider the variations in the mental spines for oral and maxillofacial treatment involving the mandible. Differences in anatomy of the mental spine, including their number, location, and size, can impact diagnosis and treatment approaches.

Key words: Cadaver, Oral cavity, Mandible, Osteology, Anatomy

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Introduction


The mental spines (genial tubercles) and the lingual foramina are part of the mandibular symphysis, located along the anterior mandible's midline and lower lingual position [1, 2]. Generally, the human mandible consists of four mental spines split into pairs, which serve as muscle attachment sites. The superior pair attaches to the genioglossus muscle, while the inferior pair attaches to the geniohyoid muscle [1].

While it has been widely accepted that the standard mandible features four mental spines, recent research has revealed that one or two distinct mental spines are possible but may also be more common than the presence of four (Fig. 1) [3]. Variations in the anatomy of the mental spines contrib-

ute to changes in the lingual foramina and the attachment of muscles to the anterior mandible [1, 3-6]. These changes help determine how the arteries that supply blood to the sub-mandibular region enter the mandible through the lingual foramina [7-19].

The mental spines are generally of small size but can develop into larger prominences due to calcification of the geniohyoid and genioglossus muscle tendons and severe atrophy of the mandible. This condition is referred to as the "elongated mental spine" (Fig. 2) [2, 20]. The more eminent tubercles become prone to fracturing spontaneously or due to ill-fitting dentures [9, 21-23]. To begin treatment, several radiographic techniques in differing combinations are used in oral and maxillofacial diagnoses to acquire clear images of affected regions [21, 24-31]. Next, clinical treatment of fractured mental spines is accomplished through conservative or surgical means, typically leading to successful recovery of the damaged mandible and attached muscles [31].

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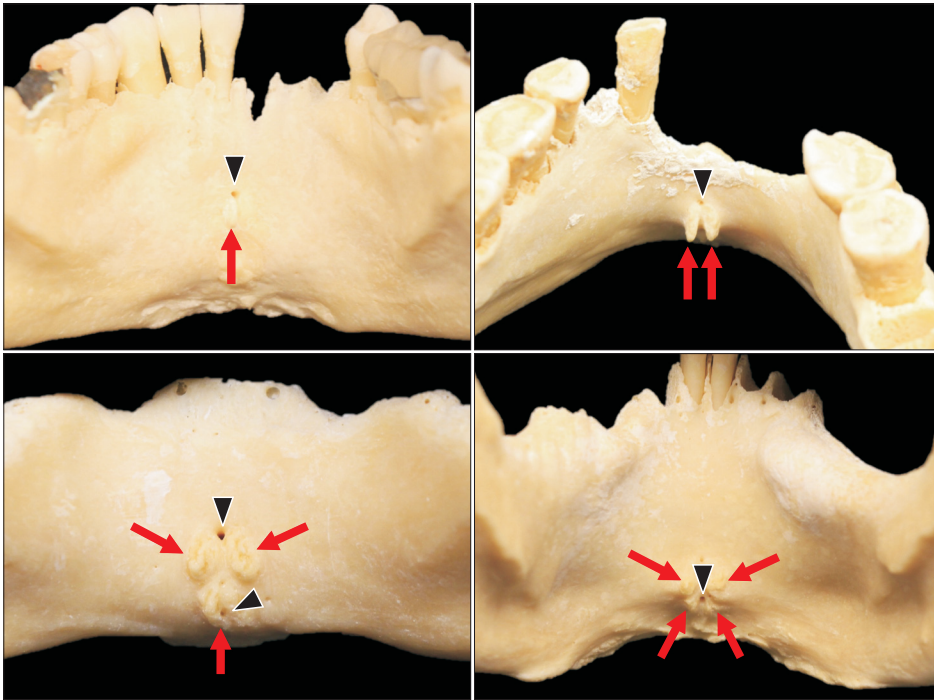


Fig. 1. Various number of mental spines (arrows). Note that the median lingual foramina are shown (arrowheads).

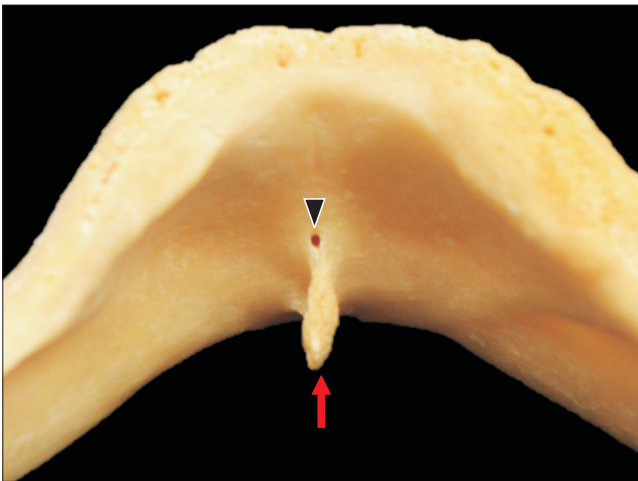


Fig. 2. An elongated mental spine (arrow) and median lingual foramen (arrowhead).

Review

Terminology

The mental spines of the mandible are also known as genial spines, genial tubercles, genial apophysis, and spinae mentalis [32]. The terms tubercle, spine, and apophysis describe bone projections that remain attached to the larger bone structure they originate from. In this case, the larger bone is the anterior mandible [33]. These terms are typically

used interchangeably, but their situational use varies depending on the size of the protuberance [2]. “Mental” originates from the Latin word *mentum*, and “genial” derives from the Greek word *genion*, both referring to the chin [33].

Anatomy

The superior and inferior pairs of mental spines are typically accompanied by lingual foramina in varying numbers, forms, and positions [1]. The lingual foramina are entrances to canals that run from the cortical bone surface to the intraosseous region on the lingual surface of the mandible [4, 6]. These foramina can be categorized by their location in relation to the mental spines [1, 3]. *Supra-spinosum* describes when the foramen is above the mental spines, *inter-spinosum* refers to when the foramen is between or at the same level as the superior and inferior mental spines, and *infra-spinosum* pertains to when the foramen is below the inferior mental spines [1, 3, 5, 6].

The sublingual artery branches into several vessels to reach different parts of the floor of the mouth. Its branches enter the lingual foramina near the mental spines as an anastomosis of vessels from the left and right lingual arteries [15].

The submental artery, the largest cervical branch of the facial artery, follows various paths. Its branches often perforate the mylohyoid muscle to enter the median lingual foramina near the mental spine or the lateral lingual foramina

into the mandible, where it can anastomose with branches of the sublingual artery and eventually reach the skin of the chin [34].

Radiology

The mental spines are usually shown as a prominence of the lingual cortical plate at the inferior mandible on cone-beam computed tomography (CBCT) (Fig. 3). Conventional CT and CBCT scans can confirm a diagnosis and determine the extent of the fracture damage [21, 31]. Lateral oblique and posteroanterior X-rays can be used in conjunction with other radiographs for a clinician to investigate the affected area [31].

Anatomical variation

Most anatomical textbooks describe the mental spines as four protuberances on the internal surface of the mandibular symphysis, arranged in two pairs placed one above the other [3, 35-41]. However, it has been discovered that human mandibles can have between one and four spines with varying positionings [3, 40, 41].

Studies have found that the most common mental spine anatomy consists of two superior spines [3, 40-42]. These spines form due to the consistent use of attached muscles pulling on the bone [3]. The genioglossus muscle attaches to the mandible via the superior pair of mental spines [2, 3]. The genioglossus muscle runs along the entire ventral surface of the tongue, so when the muscle is contracted, the tongue is drawn forward and out of the mouth [3]. The constant protrusion and depression of the tongue during deglutition leads to the greater prominence of the superior mental spines [3]. The geniohyoid muscle, attached to the mandible via the inferior mental spines (Fig. 4), runs along the anterior surface of the hyoid bone to either draw it forward when the

mandible is fixed or depress the mandible when the hyoid is fixed [3]. The less prominent inferior mental spines result from this muscle's weaker contraction and pulling force [3].

When the geniohyoid muscle originates from a linear attachment on the mandibular symphysis, a median vertical spine can replace the two inferior mental spines [43]. However, a rough impression may result when the muscle's origin is weakly attached [3].

Rarely the genioglossus and geniohyoid muscles originate from the same point of attachment on the mandible, causing the formation of a single large eminence instead of superior and inferior mental spines [39]. This single prominent eminence may sometimes form, and in some cases, no spine, ridge, or notable prominence is possible [3].

These morphological patterns of the mental spine have been investigated in some studies [3, 40, 41]. Singh et al. [3] examined 1,200 dry adult mandibles and classified them into five morphological groups. Araby et al. [40] adopted same classification for CBCT of 155 subjects. However, Hu et al. [41] investigated superior and inferior mental spines of 102 mandibles respectively and made seven groups in total for mental spine classification. The frequency of these different morphologies in the studies are summarized in the Table 1.

Clinical relevance

The mental spines play an important role in the success or failure of a patient's ability to support dentures. For patients with resorbed mandibles, the mental spines serve as a solid foundation for withstanding the vertical forces of dentures since the attachment of the genioglossus muscles allows the spines to resist resorption [44]. However, the mucosa cover-

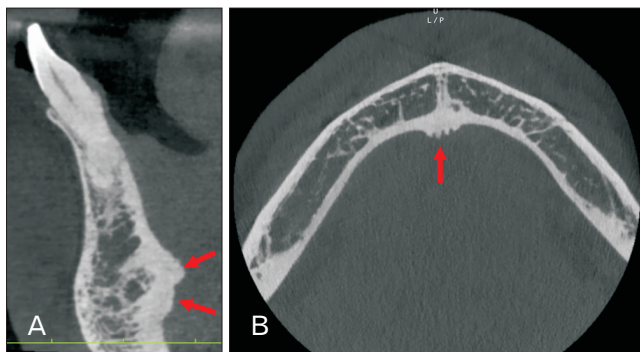


Fig. 3. (A) Midsagittal and (B) axial cone-beam computed tomography of the mental spines (arrows).

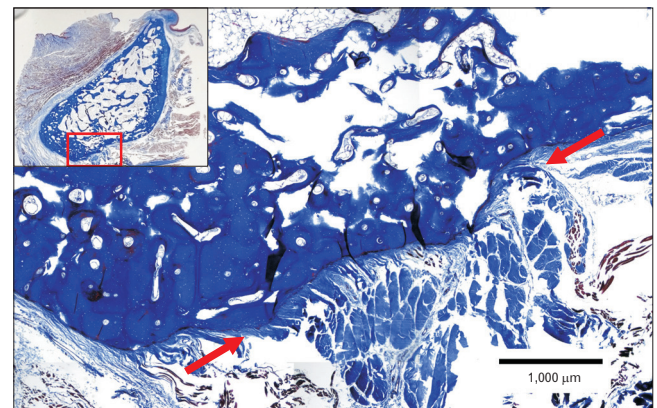


Fig. 4. Masson's trichrome staining of the para-midsagittal mandible. Note that the tendon of the geniohyoid muscle (between arrows) attaches to the mental spines.

Table 1. Variation in mental spine morphology

Type	Singh et al. [3]	Araby et al. [40]
Absent	22 (1.83)	10 (6.4)
Two pairs of spines placed one above the other	231 (19.25)	22 (14.2)
Two superior spines with median vertical ridge below	562 (46.83)	35 (22.6)
Two superior spines with rough impression below	280 (23.33)	57 (36.8)
Single prominence	105 (8.75)	31 (20)
Total	1,200 (100)	155 (100)

Type	Hu et al. [41]	
	Superior mental spine	Inferior mental spine
Sharp separation	54.3	5.7
Dull separation	10.5	2.9
Sharp fusion	7.6	31.4
Dull fusion	3.8	37.1
Triple separation	0.9	0.0
Sharp fusion (superior mental spine and inferior mental spine)		18.1
Dull fusion (superior mental spine and inferior mental spine)		4.8
Total		107 (100)

Values are presented as number (%) or percentage only. Percentages may not add to 100 due to rounding.

ing the protuberances tends to restrict the tubercles' ability to be primary stress-bearing regions [44]. If the skin has been grafted over the mental spines and the tissue overlying the muscle attachment zones becomes keratinized, this can serve as a primary support area [44].

Severe mandibular atrophy, particularly around the alveolar ridge, can leave the mental spines as hard, prominent projections, leading to fracture of the tubercles, either spontaneously or due to an ill-fitting denture [9, 21-23]. The pressure from lower dentures causes micro-fractures in the tubercles. Following this, the contraction of attached muscles leads to their spontaneous separation from the mandible [31, 45]. Clinicians have two approaches for treating fractured mental spines. The first is a conservative method, which involves pain relief and allowing the body to heal naturally. The second approach involves surgical removal of the fractured tubercle, followed by replacement or repositioning of the associated muscles [31, 46].

Conclusion

The mental spines' role as attachment sites for the genio-

glossus and geniohyoid muscles underscores their significant implications for the broader oral and facial structure. Careful attention to these mental spines and associated muscles, arteries, and bone is crucial to delivering effective and efficient care. Ongoing clinical studies enhance the methods, speed, and effectiveness of diagnosis, treatment, and recovery.

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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