

Anomalies and Clinical Significance of Mylohyoid Nerve: A Review

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Sandya Kini¹
Krishnaraj Somayaji¹
Shashirashmi Acharya¹
Shivakumar Sampath²

¹Department of Conservative Dentistry and Endodontics, Manipal College of Dental Sciences, Manipal, Manipal Academy of Higher Education, Manipal, India; ²Department of Conservative Dentistry and Endodontics, Vivekananda Dental College for Women, Tiruchengod, Tamilnadu, India

Background: The mylohyoid nerve is a branch of the inferior alveolar nerve (IAN), which is a branch of the posterior division of the mandibular nerve (MN). It is the source of motor nerve supply to the mylohyoid and anterior belly of the digastric muscle. At times, it provides sensory innervation to the mandibular teeth and skin below the chin. Since the location, anatomical variation and communications of the mylohyoid nerve are varied, it becomes clinically important to have an in-depth knowledge when treating patients for dental and maxillofacial procedures. Such anatomical variations of the mylohyoid nerve innervations may account for failure of the nerve blocks and hence, knowledge is very important for the practitioner.

Materials and Methods: A thorough literature search was done using the key words mandibular nerve, communications of the mylohyoid nerve, inferior alveolar nerve, lingual nerve, failure of dental anaesthesia, mylohyoid nerve and dental implants “from the Databases – PubMed, Scopus Embase and Web of Science (years 1952–2020)”.

Results: The mylohyoid nerve may contain motor and sensory fibres, it may pass through the mylohyoid groove or canal and communicate with other nerves, which is clinically significant. Such anatomical variations may be one of the reasons for the failure of the inferior alveolar nerve block.

Conclusion: Awareness of these variations is very significant in planning treatment and avoiding any unnecessary steps. The most frequently encountered anatomic variation of the mylohyoid nerve was innervation of the submental skin and the anterior teeth.

Keywords: mylohyoid nerve, inferior alveolar nerve, mylohyoid groove, anaesthesia

Introduction

The mylohyoid nerve (MHN) or “nervus mylohyoideus”, stems from the inferior alveolar nerve (IAN), which springs from dorsal division of the mandibular nerve (MN).¹ It is given off just before the IAN passes through the mandibular foramen (MF). Then, it passes downwards deep to the mandibular ramus, penetrates the sphenomandibular ligament to enter into the mylohyoid groove and finally lies inferolateral to the mylohyoid muscle (MM), but superior to the anterior belly of the digastric muscle (ADM).¹ Though the MHN is considered to be the motor component of the posterior branch of the MN, it is not always consisting of only efferent fibres. It has been reported to have some sensory fibres that convey cutaneous sensation below the chin and lower incisors.² The MM and ADM, involved in mastication, deglutition, respiration and speech, are innervated by the MHN.^{3,4} The nerve also carries the sensory information from other teeth.⁵ Histological study⁶ revealed that MHN contains fibres that might provide sensory

Correspondence: Krishnaraj Somayaji
Manipal College of Dental Sciences,
Manipal, Manipal Academy of Higher
Education, Manipal, India
Tel +918277025409
Email sksomayaji@gmail.com

innervation to the mesial root of the mandibular first molar, premolars, incisor teeth and the skin below the chin.⁷⁻⁹ Heasman and Beynon reported innervation of premolars, canine and incisors by the sensory fibres of the MHN in 60% of cases.¹⁰ Innervation of skin of the chin was first described by Valentin in 1843¹¹ and later reported by others.¹² According to a histological observation, Heasman and Beynon concluded the average fibre count of MHN is 1251.¹³ Due to the small diameter of the nerve it becomes difficult to detect the nerve on magnetic resonance imaging.¹⁴ The aim of this review is to discuss and make the clinicians aware of the anomalies of the MHN and its clinical implications.

Materials and Methods

A thorough literature search was done using the key words “Mandibular nerve, Mylohyoid nerve, Mylohyoid groove, Communications of the mylohyoid nerve, Inferior alveolar nerve, Lingual nerve, Failure of dental anaesthesia, mylohyoid nerve and dental implants“ from

the databases PubMed, Scopus, Embase and Web of Science (years 1952–2019). Apart from this, a literature search was also done using the phrases “Anatomic variations of mylohyoid nerve, Clinical implications of mylohyoid nerve, and Distribution of mylohyoid nerve“.

Out of a total no. of 82 preselected articles and 7 data from other sources (total=89), 5 almost duplicate articles were excluded. Abstracts were screened on the basis of their course and relations, anomalies, distribution and clinical implications. Among the screened articles, 44 articles that were clinically relevant were selected (Original article=19, Review article=5, case report=19, short communication=1, other databases=3). Articles and databases that almost resembled each other in their clinical relevance (articles not resembled=24, articles not in English=2, articles not relevant=7, other sources=4) and those which were not in English were excluded (Figure 1).

Anatomical Anomalies of the MHN

Although the MHN classically arises from the IAN, it has different anatomical variations. Such anatomical anomalies cause anaesthetic failures. The origin of the MHN from the IN varies from 13.4 to 14.7 mm superior to the MF¹⁵ (Figure 2). Reports of MHN origin from the trunk of the MN are seen in about 10% of cases.¹⁶ In these cases, MHNs were posteromedial to the IAN.¹⁷ In about 45% of cases, the terminal branches of mylohyoid nerve pass through the

Schematic representation of materials & Method

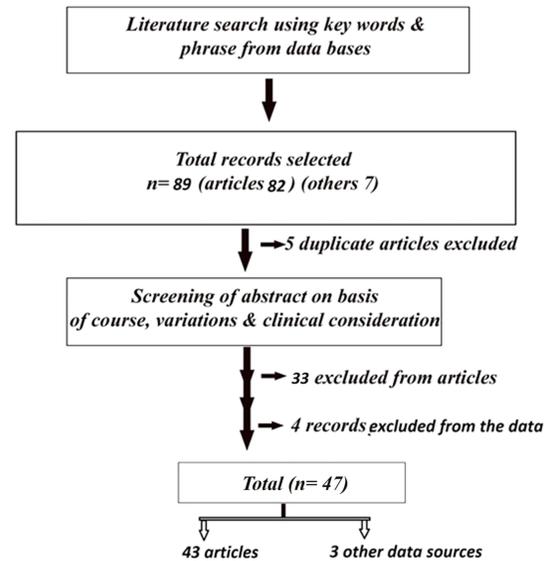


Figure 1 Schematic representation of materials and method.

small foramina near the symphysis menti of the lower jaw or immediately inferior to premolars to supply the lower incisors, premolars and their soft tissues.^{18,19} Sutton demonstrated an additional opening related to the MHN and the mylohyoid groove on the deep surface of the lower jaw.²⁰ Haveman and Tebo observed the presence of openings on the medial surface of the mandible in 53.5% cases during their study on 150 dry crania.²¹ In 68.92% of the samples, a small foramen was observed on the lingual aspect of the mandibular base opposite the premolar region.²² Adding on to the complexity of the MHN variations, there are reports

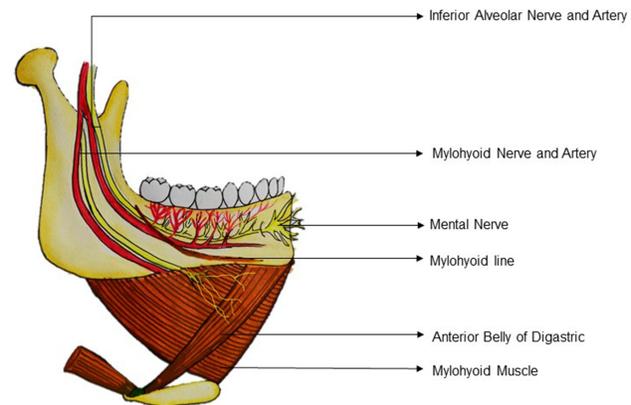


Figure 2 Normal course and distribution of the mylohyoid nerve. Figure shows digastric and mylohyoid muscles. It depicts the normal course and distribution of the inferior alveolar and mylohyoid nerves and arteries. The inferior alveolar nerve and artery are within the mandibular canal. The mylohyoid nerve and artery are in the mylohyoid groove in the medial surface of the mandible.

of communications of the LN and MHN.²³ Jablonski et al reported the origin of the MHN from the LN. In such cases, sensory fibres of the LN may supply mandibular teeth via branches of the MHN.²⁴ Sinha et al²³ reported communication of the mylohyoid and lingual nerves, showing that some of the afferents of the MHN may also supply the tongue, teeth and the skin below the chin. Such communications close to the lower third molar are susceptible for nerve injury during third molar extraction. Sato et al reported, in 1.45% of cases, two large communications between the MHN with the LN in submandibular and submental regions.²⁵ However, Kameda reported 46.3% connection between these nerves.²⁶ An unusual communication between these nerves also was reported after the LN crossed the mandibular third molar³ (Figure 3). The MHN furnishing branches to the muscles and submandibular gland was also reported.²⁷ Other documented variations of the MHN include its origin from the ninth cranial nerve or LN and communications with the plexus of IAN.¹⁷ There are case reports of the mylohyoid groove and the nerve duplicated, constricted or rarely covered by an osseous bridge.²⁸ Iwanaga et al²⁸ observed the presence of the mylohyoid canal with many orifices of the mandible. Bennett and Townsend reported incidences of terminal branches of the mylohyoid nerve entering the accessory foramina on the lingual aspect of symphyseal or premolar regions of the lower jaw, to furnish the nerve fibres to the anterior and posterior lower teeth.¹ Branches of the MHN within the mandibular canal may directly supply incisor teeth and gingivae or join the incisive nerves of the same or opposite side. Bennett and Townsend,¹ in their study, observed the conversion of the mylohyoid groove containing the

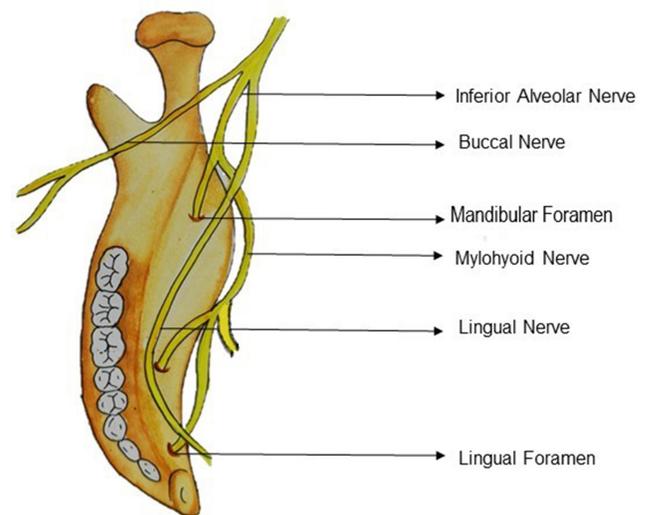


Figure 4 Relationship of the mylohyoid and lingual nerves, medial aspect of the mandible. Figure of the right half of the mandible, viewed from the inner aspect or medial aspect. Lingual nerve relation to the third molar tooth. The mylohyoid nerve gives branches which pass through the retromolar and lingual foramina to supply teeth and continues to supply motor branches to muscles.

mylohyoid nerve into a mylohyoid canal by a bridge or plate of bone. Some authors⁸ were of the opinion that supplementary sensory branches of the MHN passed through the accessory lingual foramina of mandibular symphysis or inferior retromolar foramen to supply the incisor teeth and the gingivae (Figure 4). The nerve also communicated with the incisive nerve of the ipsilateral or contralateral side.⁸ Varol et al reported that the MHN during its course has also been shown to give periosteal twigs to the inner cortex of the mandible and fine sporadic filaments to the LN in the pterygomandibular space.²⁷ The MHN gave many filaments to the MM, submaxillary gland, one sensory

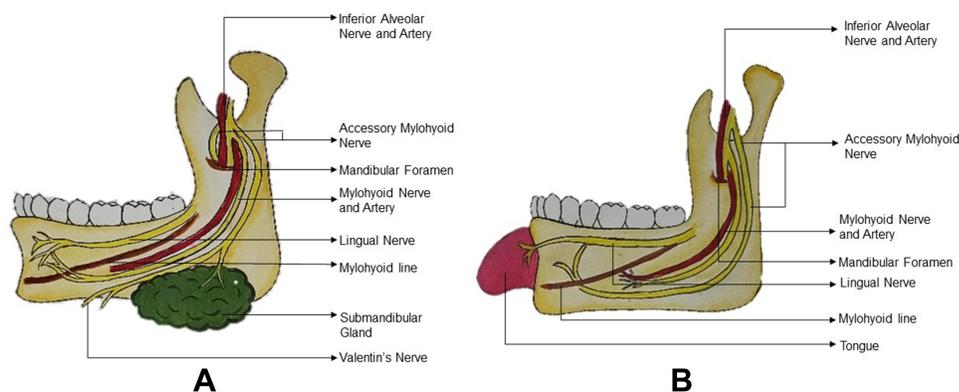


Figure 3 Anatomical variations of the mylohyoid nerve. (A) Medial surface of the mandible with the submandibular gland in the submandibular fossa. The lingual nerve communicates with the mylohyoid nerve. The accessory mylohyoid nerve gives a cutaneous branch (Valentin's nerve) and a branch to the submandibular gland. The accessory mylohyoid nerve rarely passes through the mandibular canal. (B) The accessory mylohyoid nerve gives a communicating branch to the lingual nerve through which it contributes sensory fibres to the tongue. In lingual nerve damage during third molar extraction, some tongue sensations are carried by the mylohyoid nerve/accessory mylohyoid nerve.

branch to the skin along its course, periosteal twigs to the inner cortex of the lower jaw, fine sporadic branches to the LN, distal branches to the ADM and a terminal cutaneous branch called Valentin's^{27,29} nerve to the skin of submental area. The IAN before entering the MF gave medial and lateral accessory mylohyoid branches, and the medial branch divides into branches to supply the upper and lower surfaces of the MM independently. Its lateral branch communicates with the LN³⁰ (Table 1).

Results

Variations in the origin, course, communications and distributions of the MHN can be one reason for failure of the IAN.

1. Type of nerve fibres contained in the mylohyoid nerve

Motor fibres supply the MM and ADM, sensory fibres may supply a small area of submental skin, variable number of teeth and sometimes the submandibular gland and LN.

Table 1 Anomalies of the Mylohyoid Nerve

Variation of the MHN	Normal Anatomy	Variation in the Origin
Variation of origin of the MHN near the mandibular foramen	Normally arises from the IAN 13.4–14.7 mm above the mandibular foramen	<p>a. Mylohyoid nerve (MHN) - arising by two roots, one from the mandibular nerve (MN) and another from the inferior alveolar nerve (IAN). Becomes separated at a distance of 14.1 mm from the mandibular foramen, runs within the mandibular canal for 24.3 mm and exits through a foramen on the right side (Nayak and Soumya, 2020).⁴⁵</p> <p>b. MHN arises from the trunk of the mandibular nerve in 10% of specimens (Kumar et al, 2010).¹⁶</p> <p>c. MHN originating within the mandibular canal (Nayak and Soumya, 2020).⁴⁵</p> <p>d. Accessory mylohyoid nerve may originate from the inferior alveolar nerve (Swetha and Gitanjali, 2018).³⁰</p> <p>e. Origin from the lingual nerve/glossopharyngeal nerve (Tubbs et al, 2016).¹⁷</p>
Variation in course of the nerve	Normally runs in the mylohyoid groove (83.6% runs in the mylohyoid groove)	<p>Diversity of its course</p> <p>a. Runs within the mylohyoid canal for 24.3 mm and exits through a foramen (Nayak and Soumya, 2020).⁴⁵</p> <p>b. MHN covered partially or completely by the mylohyoid canal (16.4%) (Bennett and Townsend, 2001).¹</p> <p>c. Runs in the mandibular canal (Nayak and Soumya, 2020).⁴⁵</p> <p>d. Passes through the lingual foramina in the midline of the mandible (Choi et al, 2019).⁴³</p> <p>e. Passes the accessory foramina below the premolars and supplies the premolar teeth (Bennett and Townsend, 2001).¹</p> <p>f. Communicates with the lingual nerve close to the digastric tendon (Sato et al, 2004).²⁵</p>
Variation in its innervation	Normally supplies anterior belly digastric and mylohyoid muscles	<p>Variations in innervation</p> <p>a. Supplies premolar, canine and incisors of the mandible in 60% of cases (Heasman and Beynon, 1986).¹⁰</p> <p>b. In 43–50% of the population, terminal branches of the mylohyoid nerve innervate mandibular incisors, premolars and related gingivae (Choi et al, 2019).⁴³</p> <p>c. Branch to submandibular gland (Varol et al, 2009).²⁷</p> <p>d. nly lower incisors (Bennett and Townsend, 2001).¹</p> <p>f. Terminal cutaneous branch-supplies skin of the submental region (Valentin's nerve) (Choi et al, 2019).⁴³</p> <p>g. Sensory supply to the lower lip (Bennett and Townsend, 2001).¹</p> <p>h. Accessory MHN innervating mylohyoid muscle (Swetha and Gitanjali, 2018).³⁰</p>

2. Course of the nerve

Normally through the mylohyoid groove, sometimes in the mylohyoid canal.

3. Communication with other nerves

The LN, glossopharyngeal nerve and nerve of the contralateral side.

Discussion

It is very significant for the surgeons to be thorough with the anomalies of the MHN in order to avoid injury and complications to the MHN and its branches during maxillofacial procedures.²⁷ Transient reduced sensation of the lower aspect of the chin around the mental prominence of both sides was reported by a patient after genioplasty due to the damage of cutaneous branches of the MHN.³¹ Third molar extraction and submandibular glandectomy may also damage the MHN and its branches.^{32,33} Extraction of the last mandibular molar may injure the communications between the MHN and LN, leading to impairment of anterior two-third tongue sensation. Varol et al reported damage of the MHN during reduction of the mylohyoid ridge, symphysis/parasymphyseal fractures and severing of muscles in the floor of the oral cavity in the process of genioplasty.²⁷ Hence, prior to surgical procedures, the use of an accurate method such as cone beam computed tomography is of prime importance in order to know the course of the nerve and its relation to the surrounding anatomical structures.³⁴

Injury to the LN during the surgical procedures will not lead to complete paraesthesia of the oral part of the tongue of the respective side because of communication of the LN and MHN. Such communications are also significant in the functional recovery of the LN.^{32,33} Communication of the accessory MHN nerve and lingual nerve has been reported.³⁵ These anatomical anomalies are important to understand the cause of pathological conditions like treatment failure of trigeminal neuralgia. The variations may lead to local nerve block failure or accidental surgical injuries. Awareness of abnormal connections is important in the management of lesions in the infratemporal fossa.³⁶

Investigators³⁷ had done a standardized bilateral sagittal split osteotomy in 40 hemi-mandibles of cadavers to analyse the association of the lingual fracture line and the mylohyoid groove. In 30% of cases, the mylohyoid groove is crossed by lingual fracture lines (12/40). This shows a significant relationship between the mylohyoid groove and lingual fracture line and possible injury to the MHN. The concept of the mylohyoid groove forming the line of

least resistance for the lingual fracture was therefore partly true.

Loughner et al³⁸ observed a rare entrapment of the MHN as it passes through the lateral pterygoid muscle in a cadaver. Such trauma to the MHN may result in poorly localized deep pain from the muscles supplied by the nerve. Muscular paresis can also result from long-standing pressure of the nerve. Difficulty in swallowing may also be provoked by bilateral nerve compression.

Inferior alveolar nerve block (IANB) is the normally used technique for anaesthesia for the surgeries of the mandible and procedures of the teeth. This block has a notable failure rate from 38 to 90%.¹⁸ Anatomic variations of the MHN, such as the more the distance between its origin from the IAN and the site of deposition of the anaesthetic solution, the greater are the chances the MHN may not be fully anaesthetized. Other reasons could be the presence of accessory mylohyoid nerve, potential physical barriers such as the pterygomandibular fascia and the sphenomandibular ligament that may obstruct diffusion of anaesthetic solution during an IANB. The density and shape of the physical barriers can stop effective diffusion of anaesthetic agents during IANB. In the same way, if part of the MHN course is enclosed by bone, the latter may be a potential barrier.³⁹ Other reasons for anaesthetic failures which the clinician has to keep in mind are psychological issues such as exaggerated pain and uneasiness, or even severe infections which are localized within the pterygomandibular space that reduce the effectiveness of the local anaesthesia.⁴⁰ In recent times, the dynamics of infiltration of local anaesthesia is analysed using computed tomographic imaging.⁴¹ In such failures, regional anaesthesia such as the Gow-Gates and Akinosi methods are the best techniques for cases where the conventional IANB fails. Nevertheless, these extra oral methods have the potency to lead to excess complications than standard nerve block. The clinician should be aware of the fact that the higher the needle insertion in the above techniques, the more chances of injury to the maxillary artery and the pterygoid plexus. This may lead to blanching and pain due to arteriospasm caused by piercing the maxillary artery. Tearing of the wall of pterygoid venous plexus of vessels can lead to formation of haematoma.⁴¹ Numerous additional techniques given as supplementary injection techniques include the mental and incisive nerve block, intraligamentary, intraosseous and intra-pulpal anaesthesia. Stein et al highlighted the importance of supplemental injection to the MHN for the favourable result of

IANB.⁴² Stein et al⁴² stressed the significance of mylohyoid block infiltration into the thin cortical bone of the mandible. The mylohyoid nerve anaesthesia technique is achieved by infiltrating the anaesthetic solution 1.5 cm inside the oral floor supraperiostally under the mylohyoid muscle at the level of the distal root of the first mandibular molar tooth.⁷ Clark et al¹⁸ in their study found that MHN block, with or without a concomitant IANB, will not furnish or increase anaesthesia to the lower incisors and adjacent soft tissues. At times, cross-innervations across the midline with the nerve fibres of the opposite side of the lower central incisors will lead to failure of complete anaesthesia during root canal treatment. In such cases, an additional infiltration or intrapulpal anaesthesia will be mandatory.⁴⁰

During the placement of mandibular molar implants, there is a possibility of permanent damage to the neurovascular structure of the IAN which can cause damage to venous or arterial structures leading to serious systemic complications. In such clinical scenarios, anaesthetizing the MHN and buccal nerve is a safe and simple alternative technique as compared to a standard IANB. Anaesthesia of the mylohyoid and the buccal nerves has been successful in anaesthetizing the posterior mandibular ridge.⁷ Since MHN supplies only lingual cortical bone, it is supplemental and its blockage cannot anaesthetize the lower molar tooth completely.⁴³

Microdissection studies proved the presence of both motor and sensory fibres in the MHN. Such sensory fibres of the MHN pass through the communication between the MHN and LN to provide sensory innervation to the tongue. Such innervations show the impairment of tongue sensation in lesions of the posterior part of the MHN without lesions of the LN. Such communications may also help in recovery of LN nerve function after its injury during the extraction of a mandibular third molar.³² Trigger points in the ADM which is supplied by the MHN can lead to referred pain in the tooth. Recent studies have shown feasibility of choosing the MHN as a donor in a reanimation procedure of the facial nerve. The MHN could be interchanged to the facial nerve trunk with limited morbidity.⁴⁴

Though MHN arises just before the IAN entering the MF, which is located in the ventral and inferior two-thirds of the mandibular ramus, there is a case report where the origin of the MHN is within the mandibular canal and emerged from a small mylohyoid foramen on the inner aspect of the mandibular angle. Invariably, such

understanding is of paramount importance during reconstructive surgeries of the mandibular region.^{45,46}

Conclusions

Variations of embryological origin and their ignorance can pose unusual difficulty for surgeons and clinicians. Variations are very crucial and need to be noted for procedures such as placement of implants over an edentulous mandible, osteotomies, submandibular region surgeries, removal of tori, harvesting a graft, and screw placement in cases of fracture management and also during normal clinical procedures. Knowledge of anatomical anomalies and communications of the MHN prepare the surgeon for a better diagnosis and efficient treatment planning, and minimizing complications to the patient.

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Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

Disclosure

The authors have no conflicts of interest for this work.

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