

Anatomy of the inferior alveolar nerve and its clinical implications

Anatomía del nervio dentario inferior y sus implicaciones clínicas

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Summary

Introduction: The inferior alveolar nerve is one of the terminal branches that gives off the third branch of the trigeminal nerve. Injury to the inferior alveolar nerve has a prevalence ranging from 0.53 to 8.4%. **Objective:** To analyze the most relevant aspects concerning the anatomy of the inferior alveolar nerve and its main clinical implications. **Methodology:** A narrative review was conducted, in which 19 publications were selected from the following databases: SCOPUS, PubMed, Web of Science, Google Scholar and human anatomy textbooks, during July to December 2024. **Results:** The inferior alveolar nerve can be injured in dental procedures such as the placement of dental implants, third molar extractions, lower posterior teeth, retained teeth, endodontic treatments, periradicular surgeries, orthognathic surgeries, distraction osteogenesis and mandibular trauma. **Conclusions:** It is essential to know the typical anatomy of the inferior alveolar nerve and its anatomical variants, to reduce the risk of injury.

Keywords: Dentistry, anatomy, inferior dental nerve.

Resumen

Introducción: El nervio dentario inferior es una de las ramas terminales que emite la tercera rama del nervio trigémino. La lesión del nervio dentario inferior tiene una prevalencia que oscila entre el 0,53 y el 8,4%. **Objetivo:** Analizar los aspectos más relevantes concernientes a la anatomía del nervio dentario inferior y sus principales implicaciones clínicas. **Metodología:** Se efectuó una revisión narrativa, en la que se seleccionaron 19 publicaciones en bases de datos: SCOPUS, PubMed, Web of Science, Google académico y libros de texto de anatomía humana, durante julio a diciembre de 2024. **Resultados:** El nervio dentario inferior puede lesionarse en procedimientos odontológicos como la colocación de implantes dentales, extracciones de terceros molares, piezas dentarias el sector postero inferior, dientes retenidos, tratamientos endodónticos, cirugías perirradiculares, ortognáticas, distracciones osteogénicas y trauma mandibular. **Conclusiones:** Es fundamental conocer la anatomía típica del nervio dentario inferior y sus variantes anatómicas, para disminuir el riesgo de lesiones.

Palabras clave: Odontología, anatomía, nervio dentario inferior.

1. Introduction

The inferior alveolar nerve, together with the lingual nerve, are the terminal branches of the posterior trunk of the mandibular nerve, which constitutes the third branch of the fifth cranial nerve (trigeminal nerve). The inferior alveolar nerve is purely sensory, providing sensitivity through its branches to all lower teeth, adjacent bone tissue, the vestibular gingiva, and soft tissues of the mental area (1,2,3).

Injury to the inferior alveolar nerve has a prevalence ranging from 0.53 to 8.4% (4). Considering the importance of understanding the course and branches of this nerve in preventing injury in various dental and maxillofacial procedures, it is therefore pertinent to conduct this literature review to analyze the most relevant aspects of the anatomy of the inferior alveolar nerve and its main clinical implications.

2. Methodology

A narrative description was made regarding the anatomical considerations of the internal dental nerve and its clinical implications. The search strategy took into account criteria such as: relevance and origin of the data, objective development of the content, and scope of the research. Based on these parameters, 19 publications were selected, including: review articles, original articles, textbooks, and clinical cases related to the subject of study, in English and Spanish. The information was collected from databases, platforms, and/or virtual libraries such as SCOPUS, PubMed, Web of Science, Google Scholar, as well as the human anatomy book, between July 2024 and December 2024.

3. Development

3.1. Common anatomical presentation of the inferior alveolar nerve

The inferior alveolar nerve begins about 5 millimeters inferior to the foramen ovale in the zygomatic fossa and descends anterior to the dental artery, relating medially to the internal pterygoid muscle and the interpterygoid aponeurosis . It is also related laterally to the ascending branch of the mandible and the external pterygoid muscle as far as the mandibular foramen (2,5,6).

It gives off the mylohyoid nerve before entering the inferior dental canal or mandibular canal. It runs in the inferior dental canal, gives off an internal branch, known as the incisive branch, and an external branch, which emerges through the mental foramen, called the mental nerve (5,6).

In histological studies of the inferior dental nerve, a single trunk has frequently been described that divides at the level of the molars into two extensive nerves that extend in a spiral: the incisive nerve and the mental nerve (7).

The mental nerve supplies branches to the skin and mucosa of the lower lip, as well as the skin of the chin. The incisive nerve, meanwhile, continues anteriorly through the mandibular canal and gives off branches to the incisors, canine, and adjacent gingiva (2,5-7).

Most radiological and cadaveric findings have reported that the inferior alveolar nerve has a plexiform configuration, receiving bony perforating branches from neurovascular bundles that emit adjacent muscular structures. These accessory alveolar nerves are especially visible in a lateral plane of each mandibular third molar and constitute a relatively frequent cause of incomplete inhibition of local pain after the application of anesthesia for inferior alveolar nerve block (2,6,8).

3.2. Anatomy of the mandibular canal

The mandibular canal, also known as the inferior dental canal or inferior alveolar canal, begins with the mandibular foramen, located on the inner surface of the mandible. The mandibular canal is located anterior to a bony eminence called the lingula. The mandibular canal passes through part of the body of the mandible and ends at each mental foramen (6,9). (See Figure 1)

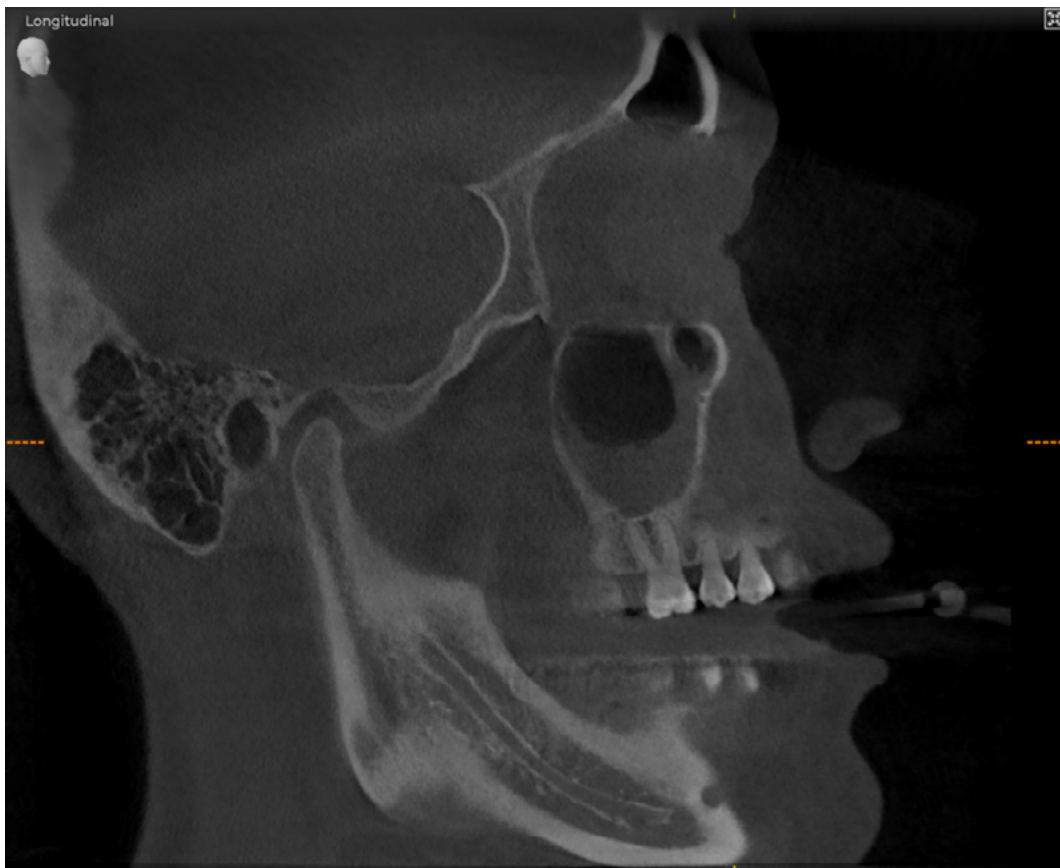


Figure 1. Mandibular canal. The sagittal section shows the course of the mandibular canal, from the mandibular foramen to the mental foramen, between which the inferior alveolar nerve runs. **Source:** Image obtained at the dental clinic of the Salesian Polytechnic University (Guayaquil campus).

3.3. Anatomical variations of the inferior alveolar nerve

The injuries of the alveolar nerve can be of great magnitude according to the scale of the pain to such an extent that they can compromise the quality of life of the patient in such a way that the adequate identification and perception of the anatomy of the inferior dental nerve is essential for any oral surgery intervention in the mandibular region. Therefore, it is important to know the variations in terms of morphology, course and its various relationships with the adjacent structures and the behavior of the nerve in its intraosseous mandibular course in order to make a good diagnosis, as well as to avoid injuries to the nerve in any dental procedure (1-4).

The inferior dental nerve mainly runs, in cadaveric dissections, with three presentations of anatomical variants: a) constituted by a single trunk that is distributed throughout all the apices of the lower teeth; b) fragmented into small branches; c) this type is initially divided into two branches, an upper one responsible for innervating the second and third molars, and a branch located apically that provides innervation to the remaining lower teeth (10,11).

Nortje & Farman (12) described four anatomical variants in relation to the mandibular canal, according to the findings detected in panoramic radiographs: a) a single bilateral and simple canal; b) a single bilateral canal, but with a radiologically intermittent path; c) several small-caliber canals; d) mandibular canal not visible or with a double shape.

Among the most common variations we can find the double or bifid inferior alveolar nerve, described in the study carried out by the aforementioned authors, who indicate that up to 0.9% of individuals had a bifid nerve displayed in the x-rays taken, of which 20% were bilateral and 13% were unilateral. Therefore, within the contextual study of the mandibular area, these variations in the anatomy that can be detected from the radiological level are considered together and that may be subject to variations in age, taking into account that, the older the patient,

the mandibular canal through which the inferior alveolar nerve runs is usually located in a higher position (12).

3.4. Clinical implications of the inferior alveolar nerve.

In dental practice there are numerous procedures performed on the jaw, to mention a few examples: placement of dental implants, extractions of third molars, teeth in the lower posterior sector, retained teeth, endodontic treatments, peri-radicular surgeries, orthognathic surgeries, osteogenic distractions, mandibular trauma, among others, and despite the fact that the anatomy of the inferior alveolar nerve is known, iatrogenic injuries of the inferior alveolar nerve are well documented (13).

Among the most frequent injuries of the inferior alveolar nerve due to lack of knowledge of its anatomy are: lacerations, neurosensory injuries such as neurapraxia, axonotmesis and neurotmesis that can occur due to compression or stretching. In the first, the nerve is anatomically intact, but is unable to conduct the nerve impulse. This can be caused by any type of external pressure (14).

The Axonotmesis is a more severe injury because it involves axonal degeneration. The main clinical implication is that it requires a longer recovery period compared to neurapraxia. On the other hand, axonal degeneration requires a longer recovery period. In neurotmesis, there is a complete disruption of the axon and the myelin sheath. Complete deterioration of nerve function is evident, in which case surgical intervention is indicated (14).

Neurosensory lesions can cause chronic pain and complete anesthesia of the areas innervated by the affected nerve. Chemical damage may also occur from components used in endodontic treatments such as formaldehyde, corticosteroids, eugenol, and sodium hypochlorite. Thermal damage may occur due to bone overheating during procedures (15).

The technique for procedures on third molars that are anatomically related to the inferior alveolar nerve consists of anesthesia, incision, osteotomy, odontosection, and extraction. An intentional coronectomy has been proposed to allow mesial migration of the tooth and avoid injury to the inferior alveolar nerve (4).

3.5. Damage to the inferior alveolar nerve

Damage to the inferior alveolar nerve is a significant complication in dentistry and oral surgery. The inferior alveolar nerve is responsible for sensation in the jaw, lower teeth, and lip, so injury to it can result in partial or complete loss of sensation in these areas, as well as neuropathic pain. The most common causes of damage to the inferior alveolar nerve include the extraction of third molars (wisdom teeth), dental implants, orthognathic surgery, endodontic procedures, lateralization of the nerve, and mandibular fractures. Inflammatory diseases, such as osteomyelitis, can also affect this nerve (16).

Symptoms of inferior alveolar nerve damage vary depending on the severity of the injury and include paresthesia (tingling), anesthesia (complete loss of sensation), and neuropathic pain (pain caused by the nerve injury). Diagnosis of inferior alveolar nerve damage is made by a combination of clinical evaluation and imaging tests, such as X-rays and computed tomography (CT). Sensory testing is also useful in assessing the degree of nerve injury (17).

Treatment for damage to the inferior alveolar nerve depends on the severity of the injury. Options include: a) **Conservative treatment:** Pain medication, anti-inflammatory drugs, and regular follow-up to observe the nerve's natural recovery; b) **Surgical interventions:** In severe cases, procedures such as nerve decompression and microsurgery may be considered to repair the nerve; c) **Physical therapies:** Electrical stimulation and low-level laser therapy can aid in nerve regeneration and functional recovery; d) **Prognosis:** The prognosis for recovery from damage to the

inferior alveolar nerve varies widely. Factors such as the patient's age, the extent of the damage, and the promptness of treatment influence the results. Most patients experience some improvement over time, although some may have permanent after-effects (18).

Proper management of inferior alveolar nerve damage is crucial to minimize complications and improve the patient's quality of life. A combination of accurate diagnosis and individualized treatment is essential to optimize nerve recovery outcomes.

3.6. Recovery of the inferior alveolar nerve

The recovery of the inferior alveolar nerve is a topic of great relevance in dentistry due to its involvement in the sensory function of the mandible. Injuries to the inferior alveolar nerve can occur for various reasons, including dental surgical procedures, mandibular fractures and inflammatory diseases. Some therapies have been proposed for the recovery of the nerve, being some minimally invasive alternatives, such as pharmacotherapy and other more invasive ones such as decompression surgical interventions, each of these having its success rate (19).

Pharmacological therapies, including anti-inflammatory and neuroprotective agents, have been shown to be useful in reducing inflammation and promoting nerve regeneration. Surgical interventions, such as nerve decompression and microsurgical repair, are used in cases of severe injuries with varying results. On the other hand, physical therapies, including electrical stimulation and low-level laser therapy, have shown promising results in accelerating nerve recovery. Nerve recovery time can vary, ranging from 6 months to 1 year, or even in cases where the damage is already permanent. To verify the recovery of nerve sensitivity, a mapping of the affected area is chosen (19).

It is concluded that recovery from damage to the inferior alveolar nerve is a complex process dependent on multiple factors, and that a combination of different therapeutic approaches can offer the best results.

An individualized evaluation of each case is recommended to determine the most appropriate treatment.

5. Conclusions

The alveolar nerve is an anatomical structure of special importance in various dental procedures, such as the placement of dental implants, third molar extractions, mandibular posterior teeth, impacted teeth, endodontic treatments, peri-radicular surgery, orthognathic surgery, as well as distraction osteogenesis and mandibular trauma. Therefore, it is essential to understand the typical anatomy of the inferior alveolar nerve and its main anatomical variants.

5. Contribution of the authors

LESP: Bibliographic search, introduction, methodology, development, conclusions.

FSA: Bibliographic search, development and conclusions.

EORC: Bibliographic search and development.

SSV: Bibliographic search and development.

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