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SHORT COMMUNICATION

Histology and intramandibular course of the inferior alveolar nerve

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Abstract The morphology of the inferior alveolar nerve is a very important factor for all surgical procedures in the mandibular region. The aim of this anatomical and histological study was to describe the intramandibular course and the microscopic histology of the inferior alveolar nerve in the dissected human cadaver. Twenty partially *dentulous hemimandible* specimens from human cadavers were dissected and embalmed, and the findings were interpreted by standard and histological imaging. The result of this study showed that the inferior alveolar nerve comprises two larger nerves that are separately wrapped in perineural sheaths and spirally twisted around each other. The mental nerve exits through the mental foramen in the premolar region and the dental nerve continues from the premolar region as the incisive nerve in the incisive canal. These findings provide relevant data for clinical dentistry, especially when planning oral and dental operative treatment procedures in the mandibular region.

Keywords Inferior alveolar nerve · Histology · Mandible · Oral surgery · Dental implant

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Introduction

The intramandibular course of the inferior alveolar nerve (IAN) is very important for dental implant, root canal therapy, mandibular osteotomy, dental anesthesia, and any surgical procedures involving the mandible [1–3]. The nerve can also be injured during implant placement, local anesthesia, operations, especially when extracting the lower third molars, root canal therapy, and other oral and dental operative treatment procedures in this region. Damage of the IAN and mental nerve causes paresthesia or anesthesia of the labiomandibular region.

Therefore, knowledge of the intrabony anatomy and histology of the IAN during implant placement, osteotomies, and periapical surgery in the mandible region is essential for successful treatment for all surgical procedures in this region. Olivier [4] described two types of IAN.

Type I observed in 66% of cases, displayed the IAN as a single bundle that traveled toward the mental foramen, where it divided into two terminal branches at the mental foramen: the mental nerve exiting through the mental foramen and incisive nerve.

Type II thirty-four percent present, the nerve divided posteriorly into a larger mental branch and smaller dental branch.

Carter and Keen [5] classified the arrangement of the main trunk of the IAN into three types:

Type I Displayed the IAN as a single large structure in a mandibular canal which terminated at the mental foramen by arborisation and forming the incisor nerve plexus.

Type II IAN was located more inferiorly in the mandible, and sent more dental branches forming a plexus.

Type III IAN is divided into two large branches posteriorly which provide the innervation of teeth.

The course of the mandibular canal and IAN has been investigated in several studies [6–8] and the anatomic variations in the intrabony course of the IAN are frequent. The histological structure and the intramandibular course of the IAN have not been completely described.

The purpose of this study was to describe the intramandibular course of the IAN through direct observation in dissected human cadaver mandible and microscopic histological examination.

This knowledge provides critical and relevant data for clinical dentistry, minimizing the risk of injury to the IAN during any surgical procedure in the mandibular region.

Materials and methods

This study was based on the dissection of 20 hemimandible specimens (10 right and 10 left sides) from human cadaveric mandibles obtained from cadavers in the Institute of Anatomy of the Medical University of Graz after preserving the specimens with formalin. Five were from female and five from male cadavers. The soft tissue was carefully removed and the mandibles were divided at the mental symphysis. One half of each mandible was used for macroscopic dissection and the other half was used for histology. For the macroscopic dissection (n=10), the buccal cortical bone was removed using a scalpel and forceps. Once the buccal cortical plate had been removed, the IANs were successfully dissected by removal of bony trabeculae using instruments for microsurgery. Once dissected, the intramandibular course of the inferior alveolar nerve was observed and photographed (camera, Sony Cybershot 7.2 MP).

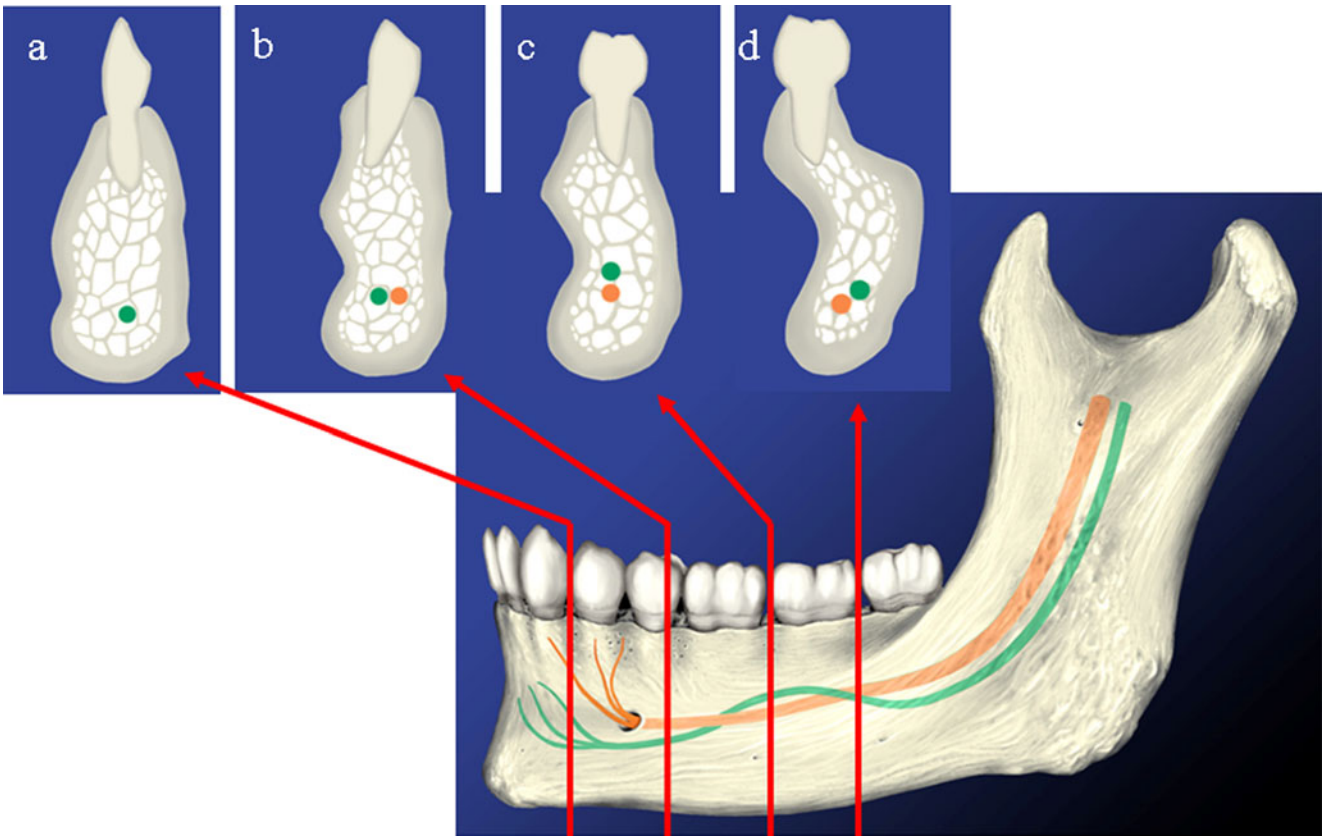

Fig. 1 Selected sectors for histological sections of the IAN in relation to mandibular teeth graded as follows: **a** between the canine tooth and first mandibular premolar, **b** distal from long axis of the second mandibular premolar, **c** between the first and second mandibular molars and **d** between the second and third mandibular molars

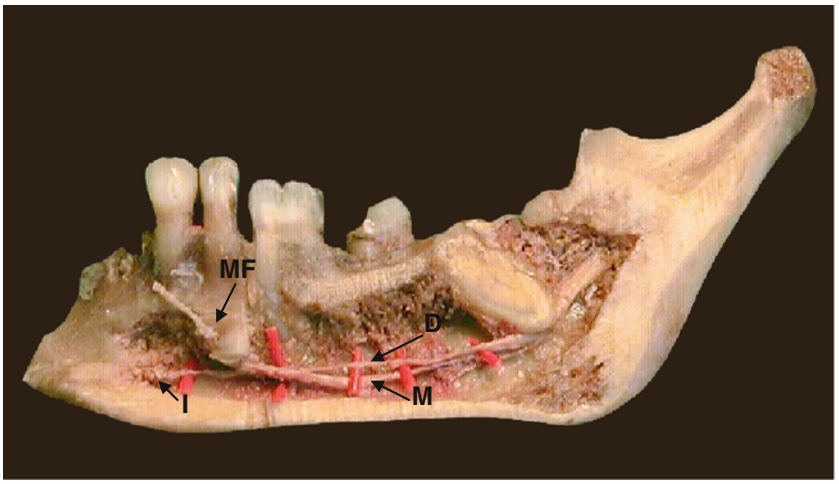

Fig. 2 Mandible prepared for anatomical study, vestibular view. Dental nerve (*D*), mental nerve (*M*), incisive nerve (*I*), and mental foramen (*MF*)

For histology ($n=10$) all specimens were fixed with 10% formalin for 72 h then rinsed, decalcified in nitric acid, dehydrated and embedded in paraffin wax. The histological sections were cut at 10 μm thickness in specific sectors selected as follows:

Section a between the canine tooth and first mandibular premolar
Section b distal from long axis of the second mandibular premolar
Section c between the first and second mandibular molars and
Section d between the second and third mandibular molars (Fig. 1)

After the sectioning was completed, the specimens were stained with hematoxylin and eosin for overview assessment of S-100 protein immunocytochemistry for Schwann cells, epithelial membrane antigen immunocytochemistry for perineurium, and examined microscopically (WILD M400 Photomakroskop).

Results

Bone slices

The mandibular canal contains a bundle of inferior alveolar nerves that comprises two distinct larger nerves that are separately wrapped in perineural sheaths in the main trunk of the IAN, one of which is the incisive nerve supplying the branches to the dental alveoli, the other is the mental nerve, which emerges from the canal through the mental foramen to supply skin and mucosa of the lower lip, cheeks, and

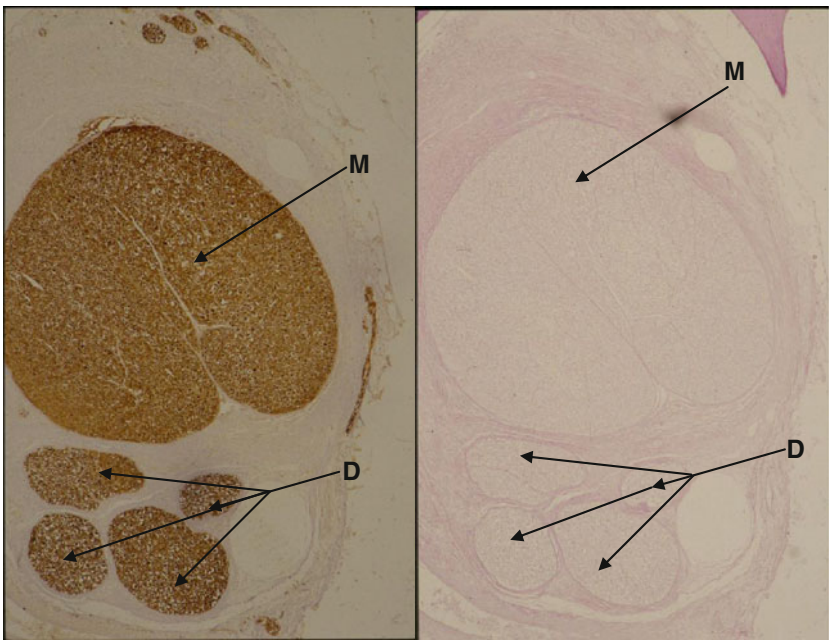

Fig. 3 Histological section of inferior alveolar nerve. Dental nerve (*D*) and mental nerve (*M*)

chin (Fig. 2). The mental nerve lies medially to the dental nerve in the posterior molar region and passes it inferiorly in the anterior molar region to finally emerge from the canal laterally in the premolar region via the mental foramen; whereas, the incisive nerve continues from the premolar region in the incisive canal (Fig. 1).

Histology

All specimens showed the IAN as a large trunk which contains two larger nerves, separately wrapped in perineural sheaths. The dental nerve consisted of three or four close nerve bundles each wrapped with perineurium. The mental nerve showed as a large bundle wrapped with perineurium. They are finally wrapped with epineurium and closed in the main trunk of the IAN (Fig. 3).

Discussion

The anatomical dissection methods used for the assessment of the anatomical structure are the most commonly used anatomical methods of investigation. The histological investigation method is essential for examining the appearance of well-described anatomical structures as compared to classical photography and radiographic methods. This in vitro study used macroscopic dissection and microscopy to describe the intramandibular course and histology of the inferior alveolar nerve.

The anatomy and morphology of the inferior alveolar nerve has been described with contradicting findings [5–8]. The histology and structure of the IAN have still not been completely identified. Previously, it has been reported that the inferior alveolar nerve ran in 66% of cases as a large single bundle in the mandibular canal [4]. Other studies found that the main trunk of the inferior alveolar nerve divided in the molar region into the mental and incisive branches which then ran parallel to one another and communicated using a network of small fibers [8], or in 41% of cases, the IAN showed a small posterior molar plexus, 37% posterior and anterior plexuses, and 22% as a single trunk with a small number of single branches [7]. In the present study, the IAN showed a large single bundle that comprises two larger nerves, spirally twisted around each other and divided in the molar area: in the *dental nerve* which continues toward the canine and incisor teeth as *incisive branch* and *mental nerve* exiting through the mental foramen. The histological findings of this in vitro study showed that both nerves are separately wrapped in perineural sheaths, finally wrapped with epineurium in the main trunk of IAN. This was clearly visualized in the histological sections. These results are in accordance with the results of Polland et al. [9] where the only difference was that they described the IAN as a large trunk containing three or four bundles of nerve fibers with connective tissue sheaths.

Recently, the histological features of the IAN have been investigated [10]. In contrast with our present study, they investigated the branches of the IAN through histological examination but not the histological internal structure of the IAN itself.

Based on these anatomical and histological findings, potential damage of the IAN during oral and dental operative treatment procedures in this region can be alleviated. Further clinical and histological studies are needed to better understand the histological relevance of the results of this present study.

Conflict of Interest The authors declare that they have no conflict of interest.

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