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Anatomical Insights into the Inferior Alveolar and Mental Nerves: A Descriptive Study in the Moroccan Population

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Abstract

Introduction: The inferior alveolar nerve (IAN) and the mental foramen are important anatomical structures in the mandible. The IAN traverses the mandibular canal from the mandibular foramen to the mental foramen. Its intramandibular trajectory may present variations, manifesting itself as simple, bifid or trifid. Identification of these variations makes it possible to plan surgery safely and appropriately. **Aim:** The aim of this study was to assess the prevalence of the various clinical presentations of the inferior alveolar nerve and mental foramen in a Moroccan subpopulation, based on the analysis of CBCT images. **Materials and methods:** A descriptive cross-sectional study was carried out in the Radiology Central Unit of the dental consultation and treatment center at Casablanca University Hospital. It concerned CBCT examinations of patients who consulted the radiology unit during the study period. Informed consent from the patients was obtained orally. **Results:** A total of 286 CBCTs of the posterior mandibular region were interpreted, divided between the right (50.7%) and left (49.3%) sides, Age and sex variations were not taken into account. The results showed that the IAN was simple in 94.3% of cases and bifid in 5.2%. The mental foramen showed a retrograde trajectory in 51.4% of cases. **Discussion:** Anatomical variations such as bifidity of the IAN and the anterior loop of the mental nerve, although uncommon in the Moroccan population studied, need to be identified during surgical planning to reduce the risk of complications. The frequency of these variations depends on the population and the imaging techniques used. CBCT imaging provides a detailed analysis of mandibular structures and is a recommended method for preoperative evaluation.

Subject Areas

Dentistry

Keywords

Inferior Alveolar Nerve, Mental Foramen, Mandibular Canal, Bifid Canal, CBCT, Cone Beam

1. Introduction

The mandibular canal (MC) is a bony conduit located inside the mandible [1]. It begins at the mandibular foramen, on the medial side of the ascending ramus of the mandible, and follows a descending, obliquely forward course through the ramus, then horizontally into the body of the mandible, to the mental foramen [1].

This canal contains the inferior alveolar neurovascular bundle, which includes the inferior alveolar nerve (IAN), as well as the inferior alveolar artery and vein [1].

The IAN is crucial because it is responsible for sensation and blood supply to mandibular teeth, interdental papillae and alveolar and periodontal bone tissues [2]. The study by Li *et al.* specifically uses the term inferior alveolar nerve canal (IAC) to refer to this structure [3].

The intramandibular trajectory is marked by the nerve division in a variable manner. Simple form, bifid (two) or trifid (three) form [1].

The bifid form has a triangular shape with its apex at the root of the lower third molar, indicating a bifurcation of the IAN [4] [5]. Some authors have reported the bifid division may be a pathognomonic sign of IAN variations [4]. Bifid or trifid mandibular canals require special attention before planning the surgical procedure [6]. Indeed, they can add to surgical complications during mandibular third molar extraction and also during implant placement [7]. In addition, one of the most common problems is inadequate and insufficient local anesthesia [6] [8].

Thanks to cone beam imaging, the latest in three-dimensional imaging techniques, we can easily explore maxilla. With the precision and definition of the cone beam images, we are able to identify the different clinical forms of IAN and the mental foramen.

Unfortunately, there is no data concerning the prevalence of the various clinical forms of IAN and the mental foramen in the Moroccan population.

The objective of this study is to evaluate the prevalence of the different clinical forms of IAN and mental foramen in the Moroccan population.

2. Materials and Methods

This is a descriptive cross-sectional prevalence study, which took place in the Radiology Department at the Center of Dental Consultation and Treatment (CCTD), CHU Casablanca, over a one-year period. The target population were patients

consulting at the radiology department, to perform a cone beam during this period. CBCT scans with significant artifacts were excluded. Informed consent from the patients was obtained orally.

For the research of the different clinical forms, a pre-established questionnaire for the collection of data was carried out. The Romexis planmeca software was used to explore the digital acquisition of each cone beam examination.

Data was analyzed using SPSS 1.9 software.

Survey support

We used a pre-established form taking into account three objectives defined as follows:

*Description of the trajectory and type of the IAN:

- Type: a quantitative variable allowing to designate the number of branches the IAN can have. Either one branch thus the nerve is simple, two branches thus it is bifid, or three branches in this case it is trifid.
- Trajectory: determined according to the proximity to the internal or external cortex. It is divided into two parts, from the 3rd molar to the 1st molar and from the 1st molar to the 1st premolar. The nerve is vestibular if it is close to the external cortex and lingual if it is close to the internal cortex. It can be said to be intermediate if it is located in an intermediate position.

*Location of the mental foramen: the mental nerve can emerge in line with the 2nd premolar, or between the two premolars, in line with the 1st premolar, as well as having other locations.

*Type of the mental foramen: a qualitative variable describing the shape of the mental nerve inside the bone. It can present a curved path forward and upward then backward forming a loop: retrograde path. Otherwise, the mental nerve can leave the mandible at a right angle, without having an intraosseous passage: straight path.

3. Results

IAN and mental foramen

We explored 286 mandibular posterior regions, with 50.7% (145) located on the right side and 49.3% (141) on the left side (See Table 1 and Table 2).

Table 1. The inferior alveolar nerve and its anatomical variables.

Characteristic of the Inferior alveolar nerve	Variables	Percentage (Frequency N)
Location	Right	50.7% (145)
	Left	49.3% (141)
Form	Uni	94.1% (269)
	Bifid	5.2% (15)
	Trifid	0.7% (3)
Trajectory	3rd molar and 1st molar	

Continued

	Vestibular	4.9% (14)
	Lingual	63.6% (182)
	Intermediate	31.5% (90)
	1st molar 2nd premolar:	
	Vestibular	30.4% (87)
	Lingual	14% (40)
	Intermediate	55.2% (158)

Table 2. Mental foramen and their anatomical variables.

Characteristic of the mental foramen	Variables	Percentage (Frequency N)
Location	Right	49.3% (137)
	Left	50.7% (141)
Emergence Position	Under the 2nd Premolar	62.2% (173)
	Between the premolars	19.8% (55)
	Under the 1st premolar	6.5% (18)
	Other	19.8% (55)
Form	Retrograde	51.4% (143)
	Straight	48.2% (134)

4. Discussion

Variations in the type of IAN

In our study, simple IAN is present in 94.1% (n = 269) of the cases, bifid IAN is present in 5.2% (n = 15) (**Figures 1-3**), while trifid IAN is encountered in only 0.7% (n = 3) of the cases (**Figure 4**).

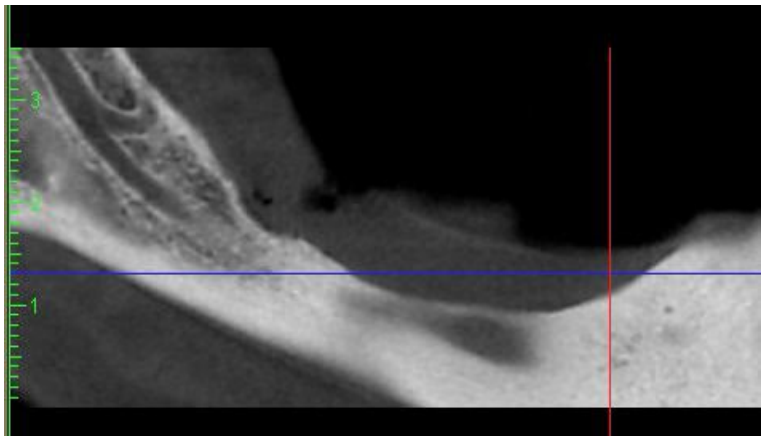

Figure 1. Bifid retromolar alveolar nerve.

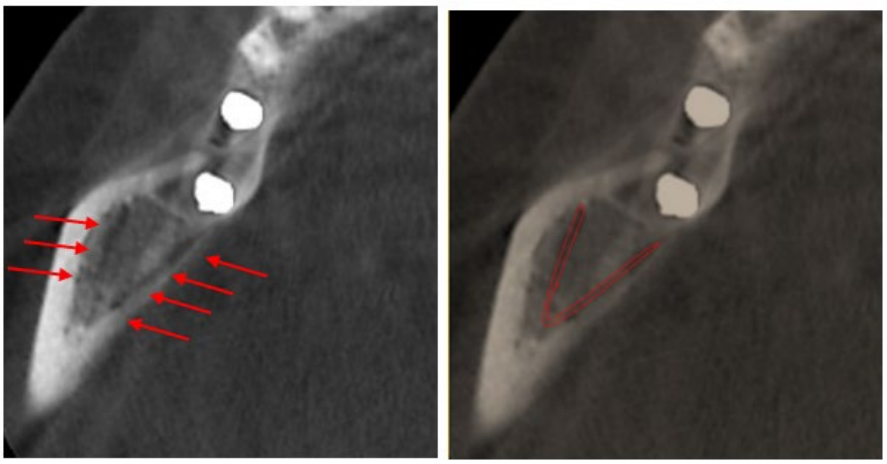

Figure 2. Bifid alveolar nerve with a vestibular branch and a lingual branch.

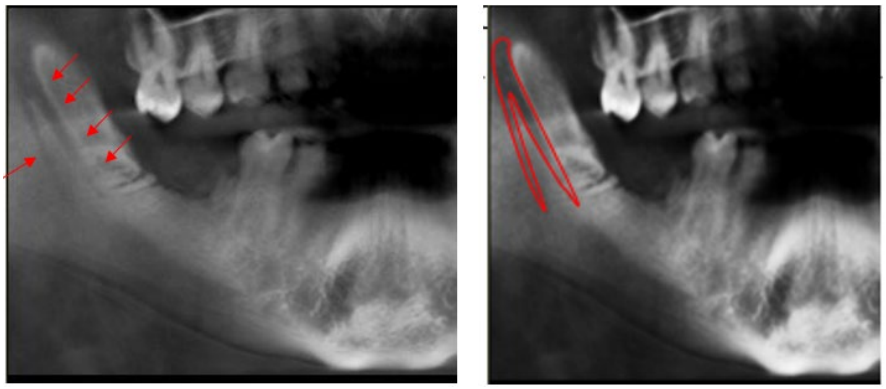

Figure 3. Bifid alveolar nerve with a cervical and an apical branch.

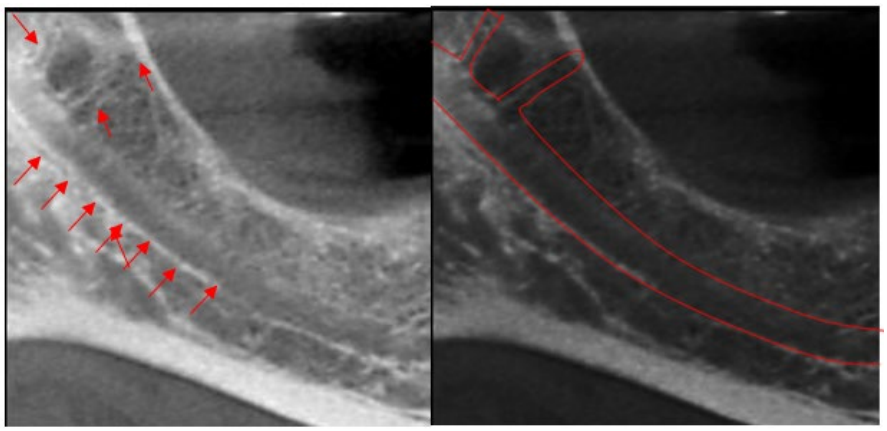

Figure 4. Trifid alveolar nerve.

The study by Haas *et al.* in 2015, revealed a 16% prevalence of bifid IAN on CBCT (7), however our result is identical to the study by Neves *et al.* 2014, which showed a 2.4% prevalence of bifid IAN [7]. Snauwaert K *et al.* in 2000 reported the presence of bifid IAN was observed more frequently with CBCT images, in 65% of patients [9]. This rate is significantly higher than our study. Another study

by Oliveira-Santos in 2012 found bifid IAN in 19% of patients [10], whereas previous studies, based on panoramic radiographs, reported an incidence less than 1% [10]. However, studies with CBCT images show a much higher incidence, ranging from 15.6% to 65% [10], whereas we found a very low incidence of this variety of IAN (See **Table 3**).

According to the study by Paul *et al.*, the most frequent variation was the bifid canal (14.7%), followed by the temporal crest canal (5.3%) and the trifid canal (3.7%) [1].

The bifid form has a triangular shape with its apex at the root of the lower third molar, indicating a bifurcation of the IAN [7] [11]. The authors reported this could be a pathognomonic sign of IAN variations [7].

Table 3. The type of study, the type of radiography and the incidence of alveolar nerves Bifid or trifid presented.

Author	Type of study	The radiography	Incidence of bifid IAN	Incidence of trifid IAN
Bogdan *et al.* (2005)	Cadaver study: 46 dried mandibular parts	__	8 cases (17.4%)	1 case (2.2%)
Naitoh *et al.* (2009)	122 patients	CBCT	79 cases (65%)	0%
CCTD (2019)	286 hemimandibules	CBCT	15 cases (5.2%)	3 cases (0.7%)

The trajectory of IAN

In our study, the trajectory of the nerve is variable. From its entry in the mandible to the 1st lower molar; the inferior alveolar nerve is vestibular in 4.9% of cases, intermediate in 31.5% of cases and lingual in 63.6% of situations. However, from the 1st molar to its exit at the level of the mental foramen, it is vestibular in 30.4% of cases, intermediate in 55.2% of cases and lingual in 14% of situations.

According to the study of T. Schneider in 2014, at the beginning of its course, the inferior alveolar nerve was vestibular in (29.0%) and lingual in (23.8%) [12].

According to yangjie li's study, on the basis of coronal views of CBCT images, the position of the MC in relation to the third lower molar roots is commonly classified into four main types: buccal, lingual, inter-radicular and inferior [3].

The study by Thao Thi Do *et al.* [2], referring to Koivisto's earlier study, presents localization results for CM in relation to the apexes of second molars, first molars and second premolars, using a classification (buccal, inferior, lingual). For second molars, the position reported was 18.75% buccal, 81.25% inferior, and 0% lingual in the results of a reported study [2]. For first molars, it was 11.36% buccal, 68.18% inferior and 20.45% lingual [2]. For second premolars, it was 12.63% buccal, 63.16% inferior and 24.21% lingual [2].

The trajectory of the mental nerve

The mental foramen is the orifice through which the terminal mental branch of the inferior alveolar nerve emerges on the lateral aspect of the mandibular body [2]. It is usually oriented superiorly, laterally and posteriorly. It can be a trap be-

cause the canal path may be retrograde (Figure 5), extending several millimeters in front of the mental foramen [13]. In case of implant placement in front of the mental foramen, this anatomical feature must be taken into account [13].

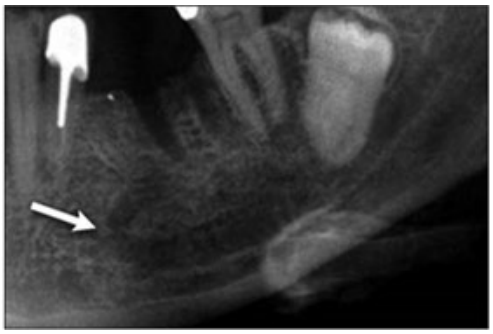

Figure 5. Mental nerve with a retrograde pathway.

In the study carried out at the Casablanca dental consultation and treatment center, the mental foramen was located in line with the 2nd premolar in 62.2% of cases, and in line with the 1st premolar in 6.5% of cases. In 19.8% of the cases the mental foramen is located between the two premolars, while in 11.5% it is located between the 2nd premolar and the 1st molar (See Table 4).

Table 4. Summary table showing the preferred site of the mental foramen according to different cadavers and CBCT studies.

study	Nature	1st premolar	Between the two premolars	2nd premolar	Between the premolar and molar	1st molar	Between the two molars	2nd molar
Our study (CCTD)	CBCT	6.5 %	19.8%	62.2%	11.5%	__		
J. M. Lorenzo 2015 (24)	CBCT	5%	25.3%	57.9%	__	2.7%	9.1%	
A. Thomas *et al.* 2012 (25)	CBCT	__	48.5%	41.1%	__	__	__	__
S. RD'dharan *et al.* 2015 (27)	Cadavers	__	__	__	__	__	__	__
Summit and Jagdish 2012	Cadavers	__	__	75.8%	__	__	__	__
Singh and Srivastav 2011 (27)	Cadavers	__	__	68.8%	__	__	__	__
Budhiraja *et al.* 2013 (27)	Cadavers	__	__	61% (R) 59.1% (L)	__	__	__	__
Rupesh and Jasmin 2001 (27)	Cadavers	__	47.6% Indien Population	__	__	__	__	__

Continued

Al-Juboori *et al.* 2013 (27)	Cadavers	—	45.1% (R) 62% (L) indo-malaysian population	—	—	—	—	—
Wang *et al.* (1986) (27)	—	—	—	58.98%	—	—	—	—
Santini and Land 1990 (27)	—	—	—	52.9%	—	—	—	—
Tebo and Telford 1950 (27)	—	—	—	49%	—	—	—	—
Xu, Y *et al.* 2014 (33)	—	—	—	58.75%	—	—	—	—

The shape and trajectory of the mental nerve

In our study, 51.4% of the canals have a retrograde course and 48.2% have a straight course (**Figure 6**).

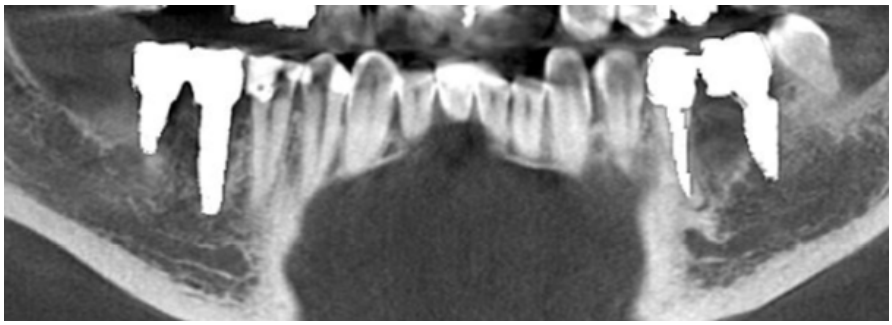

Figure 6. Trajectory of the mental nerve: straight on the right and retrograde on the left.

The retrograde pathway is a curved pathway of the mental canal—it manifests itself in the form of an arch, or as an anterior loop—its detection is of great interest in implant surgery [2] [14]. The study by Krishnan, U *et al.* shows 47.2% of the mental foramina have an anterior loop [10], these results are higher than the study by A. Thomas *et al.* which shows the presence of anterior buckle in 19.5% [15]. Kieser *et al.* (2002) examined 331 skulls to clarify the pathway of the mental nerve. The orientation of the mental canal has been subdivided as follows: forward, then backward direction "retrograde course", or at right angles to the inferior alveolar nerve "straight course" [14] [16].

The shape of the mental foramen is suggestive of the intraosseous path of the pedicle, which allows us to deduce the existence or not of the anterior loop according to its radiological appearance. When the mental foramen appears oval, there is no anterior loop, whereas if the foramen appears round, the anterior loop is present to a greater or lesser extent [17].

The prevalence of the anterior loop varies considerably in the literature. Postmortem studies by Kilic C *et al.* (2010) and Uchida Y *et al.* (2007), reported a prevalence ranging from 28% to 62.7% [3] [5], while the CBCT study by Uchida Y (2009) reported a prevalence of 71% of the anterior loop [12].

Kieser *et al.* study in 2002 reported that in white ethnic subjects, the retrograde pathway was predominant, accounting for 86.7% of cases, In contrast, in black ethnic subjects, the straight path was more frequent 45.8% [14].

A study by E.H.L. Nascimento *et al.* in 2016 showed the anterior loop of the IAN was present in 41.6% of cases [18], confirming our results. These results are similar to other results reported by Apostolakis and Brown in 2012 and Filo *et al.* in 2014, who observed on CBCT, the anterior loop in approximately 57% and 78.84% of patients respectively [18].

5. Conclusions

In the Moroccan population, the IAN is simple in 94.3% of cases, bifid in 5.2% and trifid in 0.7% of cases. The mental foramen presents a retrograde form in 51.4% of the cases, and a straight form in 48.2%.

Although postmortem studies provide important and accurate information on the prevalence and variation of anterior loop length, the cone beam examination is the examination that corresponds to clinical practice and meets the requirements of preoperative planning [16].

Despite the anatomical variability of the IAN, there is a common global pathway that should nevertheless lead to great caution: 3D imaging should be used systematically, before any procedure near the nerve, in order to detect unusual variations such as the externalization of the canal in the buccal region.

Conflicts of Interest

The authors declare no conflicts of interest.

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