Clinical Significance Of The Anterior Loop Of The Mental Nerve: Anatomical Dissection Of A Cadaver Population At The University Of The Witwatersrand

Author: Dr. Muhammad Ashraf Yoosuf Bobat Student Number 9701299H

Mdent Maxillofacial & Oral Surgery

Supervisor: Dr. R.E. Rikhotso, BDS (Wits), M.Dent, FCMFOS (SA)

Department of Maxillofacial and Oral Surgery

University of the Witwatersrand

Johannesburg

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, in partial fulfillment of the requirements for the degree of Master of Dentistry in the branch of Maxillofacial & Oral Surgery

Johannesburg, 2014

Candidate's Declaration

I, Muhammad Ashraf Yoosuf Bobat declare that this research report is my own work. It is being submitted for the degree of Master of Dentistry in the branch of Maxillofacial & Oral Surgery in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

Signed: 

On this the 10th day of November 2014

Dedication

This work is dedicated to my loving wife and children, without whose support and understanding it would not have been possible to accomplish.

Abstract

INTRODUCTION:

The anterior loop (AL) of the mental nerve is an anatomical structure that should be considered when placing dental implants in the region of the mental foramen. This study aimed to evaluate the presence and dimensions of the AL using anatomical dissection of cadaver specimens.

METHODS:

20 cadaver specimens were dissected bilaterally yielding 40 sides. The position of the mental foramen was recorded in relation to the lower border of the mandible as well as the adjacent teeth. Additionally, the mental foramen was probed before accessing the AL in order to determine the relationship between probing and actual AL length. The AL of the mental nerve was identified through anatomical dissection and measured.

RESULTS:

The mental foramen was most commonly located between the 1st and 2nd premolars (45%) followed by the apex of the 2nd premolar (42.5%). The mental foramen ranged from 10,16mm to 16,47mm from the lower border of the mandible (Mean 13,15mm; SD 1,61mm). An AL was found in 22 sides (55%) with a range of 0,52mm to 4,29mm (Mean 1,18mm; SD 1,35mm). Probing versus actual AL length revealed a weak negative correlation between AL length and probe depth.

CONCLUSIONS:

The study has shown that clinically significant AL lengths can be present and implant planning must therefore account for these AL.

Acknowledgements

I would like to thank my supervisor Dr. Ephraim Rikhotso for the guidance, knowledge and patience that he has shown to me over the course of this research project. His insight and understanding have given me the courage to persevere when I did not feel up to the task at hand and his good judgment has helped me find solutions when I could not see them myself.

I would like to thank Prof. Amadi Ihunwo for the opportunity to participate in this research project in his department as well as the welcoming environment that he provided for conducting the study.

I would like to express my gratitude to Dr. Pareen Desai for her tireless efforts as my dissection assistant. This work would not have been possible without her help.

I would like to thank Mr. Brendon Billings for accommodating my many requests with utmost graciousness and forbearance. His help will always be deeply appreciated.

Table of Contents **Page**

List of Figures

List of Tables

List of Abbreviations

AL	Anterior Loop
CBCT	Cone Beam Computed Tomography
IAN	Inferior Alveolar Nerve
IBM	Inferior border of the mandible
SCT	Spiral Computed Tomography

1. Introduction and literature review

1.1 Introduction

The inferior alveolar nerve (IAN) is a branch of the third division of the trigeminal nerve (Cranial Nerve V) that arises as the mandibular nerve exits the skull through foramen ovale. In the infratemporal fossa, the IAN enters the mandibular foramen located just posterior the lingula on the medial surface of the ramus of the mandible. The IAN follows a course within the body of the mandible, supplying sensory innervation to the posterior mandibular teeth and gingivae. The IAN terminates at the mental foramen, dividing into the mental and incisive branches. The incisive nerve supplies sensory innervation to the anterior teeth, while the mental nerve exits the mandible at the mental foramen and supplies sensory innervation to the lower lip and chin on the ipsilateral side.

The mental foramina are located bilaterally at the apical region of the first or second mandibular premolar teeth. They may be round to ovoid in shape and have a diameter of 2mm to 5mm.

Available bone for implant placement in the edentulous mandible is restricted by the anatomical position of the IAN. The mandibular alveolar bone resorbs following tooth extraction resulting in a more superficial positioning of the IAN. This limits the amount of bone available for implant placement in the posterior mandible. Implant placement, where there is insufficient bone height above the IAN, may result in neurosensory disturbances due to injury to the nerve.[1,2]

Disruption of the incisive nerve does not appear to cause significant neurosensory deficit, however, disruption of the mental nerve can cause debilitating sensory deficits such as paraesthesia or anaesthesia of the lower lip on the ipsilateral side. [2-5] Modern implant protocols take advantage of this fact, utilizing the bone in the interforaminal region for implant placement.

Stability of the final implant-supported prosthesis depends on the distance between the most distal implant and the distal end of the prosthesis.[1] A large distance results in a cantilever effect, which creates unwanted movement of the prosthesis during function. In order the minimise the cantilever, the distal implant is placed as far posteriorly as possible, close to the distal end of the prosthesis. This results in an implant position, which could be potentially close to the mental foramen.

The anterior loop (AL) of the mental nerve has been described as an anatomical loop whereby the mental neurovascular bundle crosses anterior to the mental foramen then doubles back to exit the mental foramen.[6] AL lengths of up to 9mm have been reported in the literature.[7] The presence of an AL would therefore limit the position of the distal implant and increase the cantilever effect. Studies have attempted to identify the AL using imaging modalities such as plain-film radiography as well as spiral computed tomography (SCT) and cone beam computed tomography (CBCT).[2,7,8,10]

Other workers have performed anatomical dissection of cadaver specimens to verify the existence of an AL.[2,9,7,11,12] The results of these studies have been conflicting, with reports of large AL lengths, while others report no AL at all.[7,9]

1.2 Literature review: anterior loop of the mental nerve

This section will appraise the literature for the various techniques that are used to identify the anterior loop of the mental nerve. An in-depth review on the value of plain film radiography, advanced imaging modalities and anatomical dissection in identification of the presence and dimensions of AL will be undertaken.

1.2.1 Plain film radiography

There is a general consensus that plain film radiographs are inadequate for the accurate identification of the AL.

Periapical radiography

Bavitz et al[6] compared periapical radiographs to anatomical dissection on 24 cadaveric mandibles. They could not find a reliable relationship between the anatomical dissection and the periapical radiographs in determining the AL length. The radiographic examination revealed AL lengths of 0mm to 7mm while the anatomical dissection revealed AL lengths of 0mm to 1mm. A safety zone of 1mm was proposed to avoid injury to the mental nerve. Mardinger et al, in a similar study on 46 cadaveric hemi-mandibles showed that periapical radiography show false positive presence of an AL radiographically in 40% of the sample and failed to identify the AL in 70% of the sample.[10] AL length ranged from 0,5mm to 2,95mm on periapical films and 0,4mm to 2,19mm on anatomical dissection. They proposed a safety zone of 3mm anterior to the mental foramen.

Panoramic radiography

Arzouman et al[1] conducted a study on 25 dry cadaveric mandibles using panoramic radiographs, with and without radiopaque markers, inserted into the inferior alveolar canal followed by anatomical dissection of the mental foramina. Their findings showed that the radiographs consistently under-reported the length of the anterior loop with and without radiopaque markers when compared to anatomical dissection. They demonstrated a mean AL of 3,5mm radiographically versus a mean of 6,5mm anatomically. This was attributed to image distortion by the panoramic unit, thickness of the mandibular cortical plates, which obscures the intermedullary neurovascular structures and positioning errors relating to the focal trough of the panoramic unit. Kuzmanovic et al compared panoramic radiographs to anatomical dissection in 22 cadaver specimens and found the radiographic range of the AL to be 0,5mm to 3mm and the anatomic range to be 0,11mm to 3,31mm, however, they noted that 62% of AL were not identified radiographically.[2] They proposed a new safety zone of 4mm.

Both Mardinger[10] and Rosenquist[16] were in disagreement with the findings of Arzouman et al[1] as they postulated that the rubber tubing used was too narrow and might have inadvertently entered the incisive canal, distorting the results obtained.

1.2.2 Advanced imaging modalities

Superior imaging modalities such as Spiral Computed Tomography (SCT), as well as Cone Beam Computed Tomography (CBCT), have been used for the identification of the AL. The proposed advantage of these techniques is their ability to create an accurate three-dimensional representation of the structure under investigation, thus eliminating the error of image distortion inherent in plain film radiography.

Several authors have also reported that measurements and dimensional accuracy are more precise when using CBCT over other radiographic techniques.[20,21]

Kaya et al[13] evaluated 73 preoperative patients using panoramic radiographs as well as SCT for each patient. The radiographs and SCTs were evaluated for the presence and length of an AL bilaterally. Results showed that the SCT group identified a higher number of AL's and the mean length of the AL was 3mm versus a mean of 3.71mm for the panoramic radiograph group. Li et al[14] evaluated 68 SCTs of Chinese patients retrospectively and identified an AL in 83,1% of cases. The AL lengths ranged from 0mm to 5,31mm and the authors proposed a 5,5mm zone of safety to be maintained anterior to the mental foramen.

Uchida et al[7] compared CBCT measurements to anatomical dissection and concluded that CBCT confers a high degree of accuracy when assessing the presence of an AL. More recently, Santana et al[15] compared CBCT, stereolithographic models and anatomical dissection using 12 cadaveric mandibles. They showed that CBCT has a 0,04mm discrepancy compared to anatomical dissection and that stereolithographic models may show a margin of error of up to 0,4mm compared to anatomical dissection. They concluded that CBCT is a prerequisite for identifying the AL.

Disadvantages of CBCT include limited availability, expense, higher dosage of radiation compared to conventional radiographic techniques and possible metallic streak artifacts (scatter).[22]

1.2.3 Anatomical dissection

Anatomical dissection remains the most popular method of determining the presence and length of the AL.

Anatomical dissection compared to radiographs

Bavitz et al[6] compared anatomical dissection to periapical radiographs on 24 cadaver showing an AL of 0mm to 1mm on anatomical dissection and 0mm to 7mm on periapical radiographs. Mardinger et al[10] compared periapical radiographs to anatomical dissection in 46 hemimandibles and showed an average AL of 1,05mm with a range of 0,4mm to 2,19mm.

Anatomical dissection without comparison to radiographs

Rosenquist et al[16] evaluated the AL in 58 patients who received inferior alveolar nerve transposition prior to implant surgery. They showed an AL of 0mm to 1mm with a mean of 0.15mm.

Kuzmanovic et al[2] showed a mean AL of 0.1mm to 3.3mm and consequently increased the safety zone to 4mm. More recent studies by Uchida et al[7, 12] showed AL lengths of up to 9mm. Benninger et al[9] in a study of 15 cadavers consisting of 30 sides showed the presence of an AL in only 4 sides, all of which did not exceed 1mm in length. They proposed that the large AL lengths previously described in the literature are anatomical aberrations, which are rarely encountered and thus the AL is of no clinical significance.

Previous studies have assessed the AL using radiography, advanced tomographic imaging and anatomical dissection to define a range of possible AL lengths so that a zone of safety could be established.[2,7-8,10-12] Conflicting reports of large AL lengths[7] to no significant AL lengths[9] make it difficult to adopt such a zone of safety.

Table 1 highlights the proposed safety zones postulated by various workers.

Reference	**Year**	**Methodology**	**Proposed safety zone**
Bavitz et al[6]	1993	Anatomical dissection Periapical radiography	1mm
Mardinger et al[10]	2000	Anatomical dissection Panoramic radiography	3mm
Kuzmanovic et al[2]	2003	Anatomical dissection Panoramic radiography	4mm
Dimitrios et al[19]	2012	CBCT	6mm
Li et al[14]	2013	SCT	5,5mm

Table 1. Proposed zone of safety

1.3 Significance of the study

The wide range of AL lengths reported in the literature as well as the recent assertion by Benninger et al[9] have brought the debate on the significance of the AL full circle.

Greenstein et al[17] attributed a lack of consensus on a zone of safety and the wide variety of results seen in the literature to differences in criteria used to define the AL, different diagnostic techniques and subject diversity. The use of dry skulls or cadaveric mandibles of unknown race and gender further compounds the problem since there may be anthropological and racial differences in AL length that could account for some of the diversity in the results seen in studies.

Against this background this study is undertaken to, using anatomical dissection, investigate the presence and dimensions of the AL of the mental nerve. The findings of our study will be compared to studies reported in the literature. It is envisaged that viable recommendations will emerge from this exercise which will guide clinicians when placing implants in the interforaminal region of the mandible.

2. Aims and Objectives

2.1 Aim

The aim of the study is to determine whether there is a clinically significant anterior loop of the mental nerve using anatomical dissection

2.2 Objectives

2.2.1 Primary Objective

The primary objective was to assess the length of the anterior loop of the mental nerve and to compare the right side to the left side.

2.2.2 Secondary Objectives

The secondary objectives were to report on the morphology of the mental foramen as follows:

I. To measure the position of the mental foramen in relation to the dentition and the lower border of the mandible
II. To measure the width and height of the mental foramen
III. To measure the probing depth of the mental foramen and its relationship to the anterior loop
IV. To compare the measured data from right side to the left side

3. Methodology

3.1 Population

The study population consisted of 80 cadaver specimens housed by the University of the Witwatersrand Department of Anatomical Sciences.

Inclusion criteria was:

I. Mandibular teeth up to the first permanent molar

Exclusion criteria were:

I. Edentulous mandibles

II. Absence of mandibular premolar and molar teeth

Application of the inclusion and exclusion criteria led to 20 cadaver specimens being eligible for the study.

3.2 Dissection Procedure

The anatomical dissection was performed using the following armamentarium:

- Surgical motor with surgical handpiece attachment
- Size 702 and 703 tungsten carbide burs
- Obwegeser rasps – 7mm and 9mm
- Spoon excavator
- Freer periosteal elevator
- Mitchell scaler
- Michigan probe with Williams markings
- Scalpel handle
- No. 21 surgical blades
- Digital vernier calipers

The dissection was carried out by the same examiner for all specimens.

The dissection was performed on both sides of each mandible.

An incision was made through the skin down to periosteum over lower border of the mandible and the midline of the lower lip. Skin, muscle and periosteum were reflected posteriorly to expose the buccal surface of the mandible in the region of the mental foramen. The mental nerve was incised as it leaves the mental foramen, allowing the tissues to be retracted superiorly and to expose the buccal surface of the mandible.

The width and height of the mental foramen were recorded as well as the distance from the lower border of the mandible. Distance from the lower border of the mandible was measured from the inferior-most edge of the mental foramen along a line perpendicular to the lower border of the mandible. The closest tooth apex was recorded and the mental foramen was probed using a Michigan probe.

After these measurements were recorded, the buccal cortical plate was osteotomised using surgical drills and spoon excavators. The buccal plate surrounding the mental foramen was removed to expose the underlying medullary spaces as well as the inferior alveolar canal and the inferior alveolar nerve. The medullary bone was carefully excavated until the branches of the mental nerve could be visually identified.

The course of the inferior alveolar nerve was followed within the medullary space and if the nerve looped anterior to the foramen before exiting, this loop length was measured from the most anterior part of the loop to the anterior border of the mental foramen as shown in figure 1.

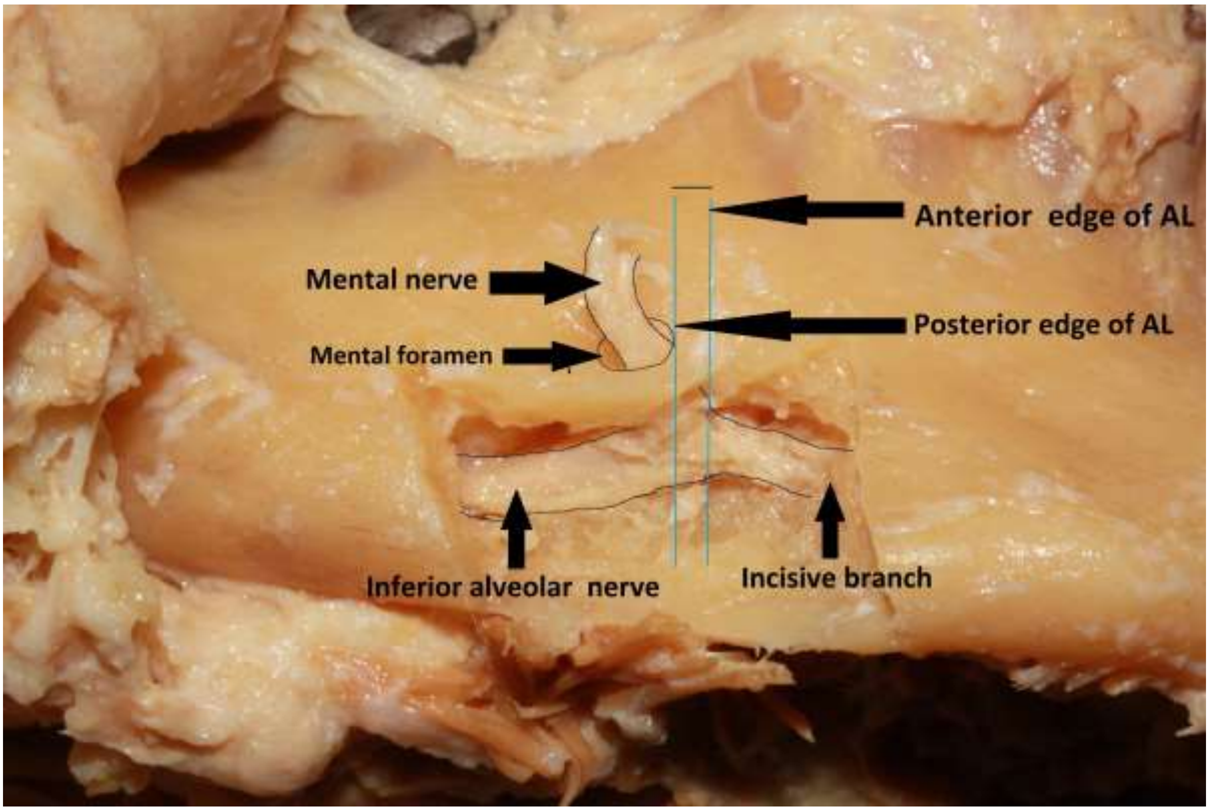


Figure 1. Determination of AL length

3.3 Data Collection

Data was recorded on the data capture form shown in Annexure A. Data was recorded for the left and right side of each specimen.

The following data was collected:

Position of the mental foramen: relationship to the nearby teeth and distance from inferior border of the mandible.

Probing depths: the superior and anterior depths of the mental foramen were probed using a Michigan probe prior to decortication and measurements were recorded

Anterior loop length: Any AL found was measured using a set of digital vernier calipers.

3.4 Data Analysis

The data was analysed using descriptive statistics and inferential statistics. The variables as outlined on the data sheet (Annexure A) were grouped into Left and Right groups.

Mental foramen position related to apex of closest tooth

- Frequency of occurrence at each recorded location
- Test for correlation between the Left and Right groups

Distance of mental foramen from inferior border of mandible

- Minimum, maximum and mean with standard deviation
- Test for correlation between Left and Right groups

Mental foramen

- Height – minimum, maximum, mean with standard deviation
- Width - minimum, maximum, mean with standard deviation

Anterior Loop length

- Minimum, maximum and mean with standard deviation
- Test for correlation between Left and Right groups
- Inferential analysis using Spearman's correlation coefficient was used to determine if the anterior loop length is related to the probing depth

3.5 Ethics

The study is covered by Waiver W-CJ-101109-1 issued to the School of Anatomical Sciences and as such does not require ethical clearance for health research performed on donated bodies.

3.6 Study Reliability

All measurements were taken by the same examiner using the same set of instruments.

In order to test intraobserver reliability, repeat measurements were performed on 3 random specimens at the end of the data capture period. The intraobserver error was noted at less than +/- 5% which was deemed acceptable.

4. Results

4.1 Demographics

The study population consisted of 20 specimens whose age ranged from 35 years to 94 years with a median age of 63 years.

The sample consisted of 15 males and 5 females. There were 16 Caucasian specimens. The remaining four were black specimens all of whom were also male.

4.2 Mental Foramen Data

4.2.1 Mental foramen position

From the 40 sides dissected, the position of the mental foramen was most commonly located between the 1^{st} and 2^{nd} premolars in 18 sides (45%) followed by the apex of the 2^{nd} premolar in 17 sides (42,5%).

A correlation test was performed which showed a 90,94% chance of the mental foramen occurring at the same position on the contralateral side.

Table 2 depicts the frequency distribution of the mental foramen.

Position of mental foramen	Right	Left
Apex of canine	1	0
Apex of 1st premolar	1	2
Apex of 2nd premolar	8	9
Between 1st and 2nd premolars	10	8
Apex of 1st molar	0	1

Table 2. Frequency of mental foramen position

Each tooth position was assigned a numerical value as follows:

- Apex of canine = 1
- Apex of 1st premolar = 2
- Between 1st and 2nd premolars = 3
- Apex of 2nd premolar = 4
- Apex of 1st molar = 5

These values were plotted on a frequency distribution table as shown in figure 2.

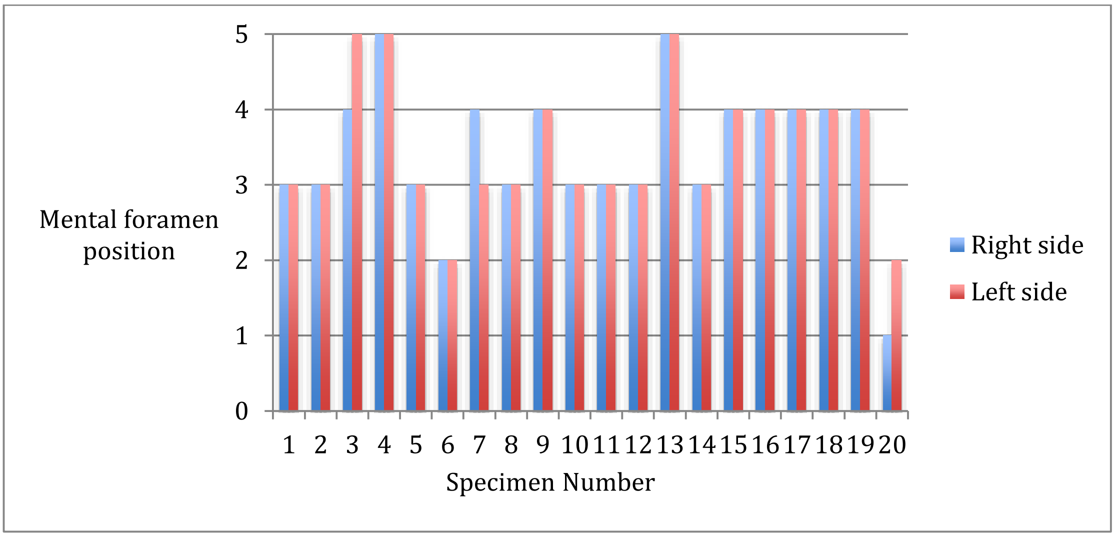


Figure 2. Frequency distribution of the mental foramen

4.2.2 Distance from the lower border

The distance of the mental foramen from the lower border of the mandible ranged from 10,16mm to 16,47mm (Combined Mean 13,15mm; SD 1,61mm). The descriptive statistics are outlined in table 3. Statistical analysis revealed an 88,71% correlation between the left and right sides.

	Right	Left
Minimum	10,16mm	10,71mm
Maximum	15,99mm	16,47mm
Mean	13,05mm	13,25mm
SD	+/- 1,69mm	+/- 1,56mm

Table 3. Distance from lower border

4.2.3 Height and width of the mental foramen

Table 4 displays the descriptive statistics for the height and width.

	Height of mental foramen		Width of mental foramen	
	Right	Left	Right	Left
Minimum	1,46mm	1,33mm	2,09mm	1,48mm
Maximum	3,08mm	3,50mm	3,81mm	3,55mm
Mean	2,18mm	2,25mm	2,71mm	2,56mm
SD	0,44mm	0,49mm	0,55mm	0,42mm

Table 4. Height and width of mental foramen

4.2.4 Probing of mental foramen related to anterior loop length

Probing of the superior part of the mental foramen did not reveal any meaningful data.

Probing of the anterior part of the mental foramen yielded lengths ranging from 0mm to 8mm.

A Spearman's rank correlation test was performed which revealed an R-value of -0,0015. This shows a weak negative correlation between probing the mental foramen and the actual AL length.

4.3 Anterior Loop Data

4.3.1 Anterior loop frequency

Table 5 shows the frequency of AL found in 40 sides of the dissected specimens. The AL was found in 55% of the sample and absent in the remaining 45%.

	Right	Left
No AL	9	9
AL present	11	11

Table 5. Frequency of AL

4.3.2 Anterior loop length

In those specimens where an AL was present, the length ranged from 1,01mm to 4,29mm (Mean 2,12mm; SD 1,00mm) on the right side and 0,52mm to 4,15mm (Mean 2,18mm; SD 1,26mm) on the left side. The combined mean value for all 40 sides was 1,18mm and the SD was 1,35mm.

The descriptive statistics for the AL are reported in table 6.

	Right	Left
Minimum	1,01mm	0,52mm
Maximum	4,29mm	4,15mm
Mean	2,12mm	2,18mm
SD	1,00mm	1,26mm

Table 6. Anterior loop length

A correlation test was performed which showed a 72,01% chance of the AL having a similar length as the contralateral side.

5. Discussion

5.1 Demographics

The sample shows a wide age range of 35 to 94 years which is similar to the data reported in other anatomical dissection studies.[9,11,12] The gender of the sample was predominantly male and the racial profile was predominantly Caucasian. This could possibly be attributed to selection bias since cadaver specimens are donated to the anatomy department.

5.2 Mental Foramen

Our data shows that the mental foramen was most commonly located at between the apices of the 1st and 2nd premolars followed by apex of the 2nd premolar. In a review by Greenstein et al[17] there appears to be some variability in the location of the mental foramen. In the Non-Caucasian populations studied the position of the mental foramen was more commonly located at the apex of the second premolar and in the Caucasian populations it was more commonly located between the 1st and 2nd premolars. Since our population was predominantly Caucasian the data is in keeping with previously reported studies.

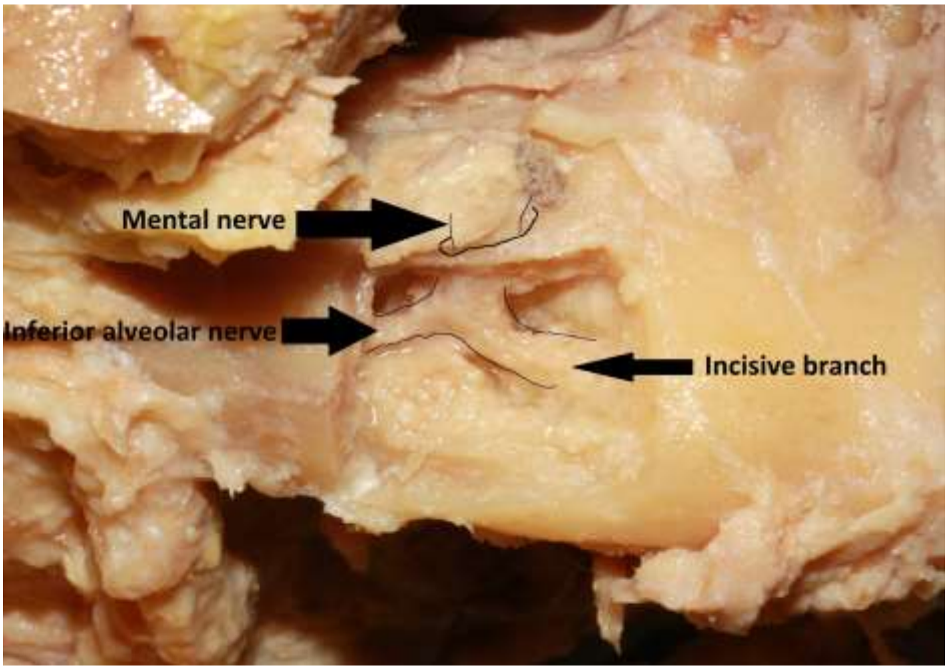
Neiva et al[18] in a study of 22 Caucasian subjects reported a range of 9mm to 15mm for the distance of the mental foramen from the lower border, a mean width of 3,59mm and a mean height of 3,47mm. Our data showed a distance from 10,16mm to 16,47mm, a mean width of 2,71mm and a mean height of 2,25mm. These findings do not deviate markedly from those previously reported and reinforce the general consensus that the mental foramen is a structure of variable location and morphology that is 2mm to 5mm in diameter, commonly occurs at the apices of the 1st or 2nd premolar teeth and is located approximately 9mm to 17mm from the inferior border of the mandible.

In this study we found that probing the mental foramen does not allow for accurate identification of an AL. The lack of correlation between probing the mental foramen and the AL collaborates with the findings of a previous study[18], therefore it is unreliable and not recommended that the presence of an AL be determined at the time of surgery using direct probing. Reasons for this might include perforation of the medullary bone with the instrument tip, or the instrument tip inadvertently entering the incisive canal when there is no AL present.

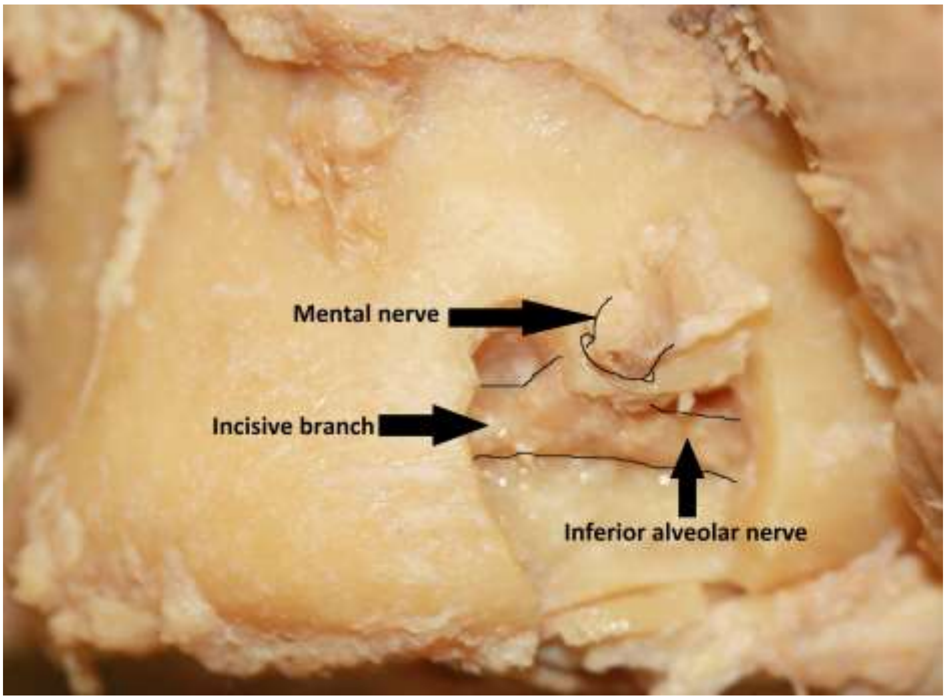
5.3 Anterior Loop

Dental implant placement in the region of the mental foramen has been known to cause neurosensory deficit due to nerve injury.[2-5] The identification and preservation of the AL of the mental nerve is an important means of avoiding such neurosensory deficit.[1,8,17]

In this study, the AL was found in 55% of the sample and the length ranged from 0,52mm to 4,29mm (Mean 1,18mm; SD 1,35mm), however AL of 4mm or greater was found in 3 sides. There was a 72,01% chance that the AL on the contralateral side would be of equal length. An interesting observation was that the morphology of the AL was not a loop. The AL branched off the inferior alveolar nerve acutely and did not curve or loop as it passed toward the mental foramen. This is similar to the finding reported by Benninger et al[9] and perhaps indicates that the term ‘anterior loop' is a misnomer since the actual morphology of this structure is a branch rather than a loop. Examples of this pattern are shown in Figure 3.



a) Figure 3a shows the morphology of the mental nerve where no AL is present



b) Figure 3b shows the morphology of the mental nerve where an AL is present – note the branching rather than looping pattern

Figure 3. Morphology of the AL

The AL range found in this study is contrary to those reported by Benninger et al[9] who found only 4 AL in 26 sides, all of which did not exceed 1mm in length. Even though there were no loops as large as those previously reported by Uchida et al[7] (9mm) the presence of loops greater than 4mm are significant and could have an impact on implant placement anterior to the mental foramen.

The introduction and widespread use of cross-sectional imaging in implant dentistry using CBCT over the past decade has enabled clinicians to diagnose and evaluate the jaws in three dimensions before and after insertion of dental implants, thus replacing CT as the standard of care, furthermore, CBCT exhibits a significantly lower radiation dose than conventional CT, but higher than that of two dimensional radiographic imaging.[20]

CBCT is known to confer a high degree of accuracy when assessing the presence of the AL of the mental nerve.[12] However, questions remain as to whether it should be routinely used to assess the presence of the AL. It is worth reminding clinicians that however accurate CBCT maybe, it is not a substitute for clinical examination. To this end we agree with the consensus statement by Bornstein et al[20] that CBCT imaging must be used when information supplemental to the clinical examination and conventional imaging is necessary. There must be a justification for their use for each patient, and the benefits should outweigh the risks.

6. Conclusion

The AL of the mental nerve is an important structure to consider when planning implant placement. Identification of this structure and an understanding of its morphology will aid the clinician in avoiding injury to the mental nerve during implant placement.

This study has shown that the position of the mental foramen is commonly located between the 1st and 2nd premolar and approximately 13mm from the lower border of the mandible. An AL was found in 55% of the sample with lengths up to 4,29mm. There was no correlation found between direct probing of the mental foramen and the AL length. Probing of the mental foramen alone is not recommended for determination of AL length.

Based on our study, we recommend that clinicians planning implant placement in the interforaminal region or around the mental foramen region be guided by the following protocol:

1. Plain-film radiography to evaluate the mental foramen region prior to implant planning.
2. Presence of AL radiographically may prompt the clinician to investigate further using CBCT or CT.
3. Placement of the implant after confirming or excluding the presence of the AL and observing the safety zones outlined below:

a. No AL found – a 2mm safety zone above and mesial to the mental foramen to allow for surgical error
b. AL present – the actual AL length plus 2mm above and mesial to the mental foramen to allow for surgical error
c. If the presence of an AL is unclear on plain-film radiographs and CBCT or CT are unavailable then a safety zone of 5mm mesial to the mental foramen should be observed

7. Limitations of the study

The study is limited by the sample size of 20 cadaver specimens.

The lack of availability of advanced imaging for the cadaver specimens is a further limitation. The use of CBCT or SCT for comparison to anatomical data would strengthen the data available as well as the conclusions reached.

8. References

1. Arzouman MJ, Otis L, Kipnis V, Levine D. Observations of the anterior loop of the inferior alveolar canal. Int J Oral Maxillofac Implants 1993;8(3):295-300.

2. Kuzmanovic DV, Payne AG, Kieser JA, Dias GJ. Anterior loop of the mental nerve: a morphological and radiographic study. Clin Oral Implants Res 2003;14(4):464-471.

3. Bartling R, Freeman K, Kraut RA. The incidence of altered sensation of the mental nerve after mandibular implant placement. J Oral Maxillofac Surg 1999;57(12):1408-1412.

4. Wismeijer D, van Waas MA, Vermeeren JI, Kalk W. Patients' perception of sensory disturbances of the mental nerve before and after implant surgery: a prospective study of 110 patients. Br J Oral Maxillofac Surg 1997;35(4):254-259.

5. Walton JN. Altered sensation associated with implants in the anterior mandible: a prospective study. J Prosthet Dent 2000;83(4):443-449.

6. Bavitz JB, Harn SD, Hansen CA, Lang M. An anatomical study of the mental neurovascular bundle-implant relationships. Int J Oral Maxillofac Implants 1993;8(5):563–567.

7. Uchida Y, Noguchi N, Goto M, Yamashita Y, Hanihara T, Takamori H, et al. Measurement of anterior loop length for the mandibular canal and diameter of the mandibular incisive canal to avoid nerve damage when installing endosseous implants in the interforaminal region: a second attempt introducing cone beam computed tomography. J Oral Maxillofac Surg 2009;67(4):744-750.

8. Ngeow WC, Dionysius DD, Ishak H, Nambiar P. A radiographic study on the visualization of the anterior loop of the mental nerve in dentate subjects of different age groups. Journal of Oral Science 2009;51(2):231-237.

9. Benninger B, Miller D, Maharathi A, Carter W. Dental implant placement investigation: is the anterior loop of the mental nerve clinically relevant? J Oral Maxillofac Surg 2011;69(1):182-185.

10. Mardinger O, Chaushu G, Arensburg B, Taicher S, Kaffe I. Anterior loop of the mental canal: an anatomical-radiologic study. Implant Dent 2000;9(2):120-125.

11. Hu KS, Yun HS, Hur MS, Kwon HJ, Abe S, Kim HJ. Branching patterns and intraosseous course of the mental nerve. J Oral Maxillofac Surg 2007;65(11):2288-2294.

12. Uchida Y, Yamashita Y, Goto M, Hanihara T. Measurement of anterior loop length for the mandibular canal and diameter of the mandibular incisive canal to avoid nerve damage when installing endosseous implants in the interforaminal region. J Oral Maxillofac Surg 2007;65(9):1772-1779.

13. Kaya Y, Sencimen M, Sahin S, Okcu KM, Dogan N, Bahcecitapar M. Retrospective radiographic evaluation of the anterior loop of the mental nerve: comparison between panoramic radiography and spiral computerized tomography. Int J Oral Maxillofac Implants 2008;23(5):919-925.

14. Li X, Jin ZK, Zhao H, Yang K, Duan JM, Wang WJ. The prevalence, length and position of the anterior loop of the inferior alveolar nerve in Chinese, assessed by spiral computed tomography. Surg Radiol Anat 2013;35(9):823-830.

15. Santana RR, Lozada J, Kleinman A, Al-Ardah A, Herford A, Chen JW. Accuracy of cone beam computerized tomography and a three-dimensional stereolithographic model in identifying the anterior loop of the mental nerve: a study on cadavers. J Oral Implantol 2012;38(6):668-76.

16. Rosenquist B. Is there an anterior loop of the inferior alveolar nerve? Int J Periodontics Restorative Dent 1996;16(1):40-45.

17. Greenstein G, Tarnow D. The Mental foramen and nerve: clinical and anatomical factors related to dental implant placement: a literature review. J Periodontol 2006; 77(12):1933-1943.

18. Neiva RF, Gapski R, Wang HL. Morphometric analysis of implant-related anatomy in Caucasian skulls. J Periodontol 2004;75(8):1061-1067.

19. Marcio BR, Bruno SS, Vinicius CM, Carlos EF. Retrospective study of the anterior loop of the inferior alveolar nerve and the incisive canal using cone beam computed tomography. J Oral Maxillofac Implants 2013;28:388-392.

20. Bornstein MM, Al Nawas B, Kuchler U, Tahmaseb A. Consensus Statements and Recommended Clinical Procedures Regarding Contemporary Surgical and Radiographic Techniques in Implant Dentistry. Int J Oral Maxillofac Implants 2014;29(Supplement):78-82.

21. Tyndall DA, Price JB, Tetradis S, Ganz SD, Hildebolt C, Scarfe WC. Position statement of the American Academy of Oral and Maxillofacial Radiology on selection criteria for the use of radiology in dental implantology with emphasis on cone beam computed tomography. Oral Surg Oral Med Oral Pathol Oral Radiol 2012;113(6):817-26.

22. Jeffcoat M, Jeffcoat RL, Reddy MS, Berland L. Planning interactive implant treatment with 3-D computed tomography. J Am Dent Assoc 1991;122(11):40-44.

9. Annexure A

Data Collection Sheet

Specimen number: __________________

Mental nerve position:

Side	Right	Left
Closest tooth		
Distance from IBM		

Probing depths:

Side	Right	Left
Superior depth		
Anterior depth		

Anatomical Dissection:

Side	Right	Left
Width of mental foramen		
Height of mental foramen		
Anterior Loop length (if present)		