

PREVALENCE AND ANATOMICAL VARIATIONS IN THE MANDIBULAR LINGUAL CANAL IN A SAMPLE OF EGYPTIAN POPULATION USING CBCT: A CROSS-SECTIONAL STUDY

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ABSTRACT

Aim: With the development of surgical procedures, as the mandibular anterior dental implants and chin surgeries, there has been an increase in complications associated with anatomical elements in this anterior area. One of the most dangerous complications is related to bleeding caused by injured vessels associated with the lingual foramen and canal, which can cause a compression of the airway.

Methodology: Eighty-two CBCT scans for Egyptian individuals were collected from the data base available at the Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Cairo University. Scans were selected according to specific inclusion and exclusion criteria, they were interpreted by two oral radiologists and analyzed in the three planes axial, coronal and sagittal. The midline was drawn on the axial scan by a line passing through the convexity of the genial tubercle to the mental ridge. The procedure was then standardized by adjusting the slice thickness and the spacing between all cuts at 0.4mm. After determining the midline on the axial plane, from the sagittal plane five consecutive cuts were taken on each side of the midline, these cuts were used for the assessment of the prevalence and the number of lingual canals present.

Results: All patients in our study had at least one median lingual foramen and canal. Regarding the number of lingual foramina; twenty subjects (24.4%) showed single lingual foramen, thirty-seven subjects (45.1%) showed two lingual foramina, nineteen subjects (23.2%) showed three lingual foramina, five subjects (6.1%) showed four lingual foramina while only a single case (1.2%) showed six lingual foramina. In males, the most prevalent number of lingual canals was two lingual canals (40%) followed by three lingual canals (28.6%). On the other hand, in females, the most prevalent number of lingual canals was two lingual canals (48.9%) followed by one canal (27.7%).

Conclusion: These anatomical landmarks in Egyptian population vary from previous as well as other studies that were conducted on different populations. Where; all of the images had at least one lingual foramen which demonstrates high prevalence of this anatomy with different variations among Egyptian population. Therefore, it is recommended to use CBCT imaging for preoperative evaluation prior to installing dental implants.

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INTRODUCTION

The lingual foramina (LF) and their bony canals are located at the internal surface of the anterior region of the mandible (*Von Arx et al. 2017*)³⁵, typically described to be between the mental foramina, in the interforaminal zone. The interforaminal zone is defined by its thin alveolar process and contains the region of the mandible with the four incisors, two canines and two first premolars (*Tagaya et al. 2009*)³⁴.

In the past century surgical procedures in the lower anterior segment of the mandible including orthognathic surgeries, dental implants (which are considered as the current preferred line of treatment for the prosthetic rehabilitation of edentulous patients), bone grafting, and lowering genial spines procedures of edentulous patients have become more frequent (*Assari et al. 2017 & Aoun et al. 2017*)^{4,3}. This area in the past has traditionally been considered as a “surgical safe zone” because of the absence of important superficial nerves or vessels. However, reports of unexplained bleeding and sublingual hematoma after genioplasties and endosseous implant placement have spurred research into the content and the vascularity of the area (*Kusum et al. 2015*)²⁴.

Studies conducted on cadavers have shown that branches from the sublingual and/or submental arteries go through these anatomic structures. Therefore, despite being generally considered as a safe area during performing surgical procedures, this mandibular region may present a real life-threatening hemorrhage from the above cited arterial branches following the lingual cortical plate trauma (*Longoni et al. 2007, Marzook et al. 2019 & Jayabalan and Muthusekhar 2020*)^{26,27,20}.

It was reported by many authors that during implant placement in the anterior region of the mandible a wide hematoma with a large swelling of the floor of the mouth occurs which later leads to a serious upper airway obstruction; this condition being related to the lingual cortex rupture and/or

perforation (*Del Castillo-Pardo de Vera et al. 2008, Jaju et al. 2011, Barrientos-Lezcano et al. 2021 & Blanc et al. 2021*)^{11,18,6,8}.

Cone beam CT (CBCT) offers three-dimensional radiographic imaging which has enabled the detailed study of bony structures with accuracy that was previously only possible by examination of cadavers. Comparing its dose to medical CT, it has greatly reduced doses of radiation becoming a routine diagnostic tool in implant planning and in revealing any anatomical variations.

Studies that demonstrate the variability in the mandibular lingual canal and its bony canals among the Egyptian population are in sufficient as we only found two papers *El Dessouky 2016 & Ahmed DF and Abd Alsamad 2018*^{14,2}, and the latter was made on specific age group as it included only edentulous patients. That’s why; this study was conducted to detect these variations using CBCT analysis.

MATERIALS AND METHODS

Out of a total 400 scans of the mandible which were taken from the data base available at the department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Cairo University and according to our inclusion and exclusion criteria a total sample of 82 scans of the mandibular anterior region and full arch mandible belonging to Egyptian individuals were chosen and examined. The scans included **47** female patients and **35** male patients, with the age of 18 or above, both dentition and partially edentulous conditions. In addition, the scans had to show either the anterior region (from second premolar to second premolar on the other side) or the whole mandible. Included scans had to be of a good quality and their voxel resolution 0.4mm to ensure the accurate detection and interpretation of the scans.

Exclusion criteria was, the absence of patients’ records status and data such as name, sex, or age, presence of any deformities of the mandibles, any pathologic conditions or impacted teeth in the anterior region of the mandible, history of

fracture and previous iatrogenic manipulation of the mandible that altered the anatomical structures. CBCT images were obtained from the available CBCT scans of Egyptian patients which were taken as a part of their dental examination, diagnosis or treatment planning during the years 2017-18-19. This was done to avoid exposing the patients to unneeded radiation dose for the research purpose, and the study was approved by the ethics committee of Cairo University in 2019.

Retrospective data analysis was performed after CBCT images were collected from the computer database. All CBCT images were acquired in a digital DICOM format. The images were then imported to *Planmeca Romexis® Viewer* (Romexis version 6.0.1.812; Planmeca OY, Helsinki, Finland) the slice thickness and the spacing between slices were standardized to be 0.4mm in the three orthogonal planes. All measurements were done independently by two oral and maxillofacial radiologists (with different experiences). The first investigator (main researcher) performed the measurements twice on two different sessions with a time period of two weeks between the two attempts. A session including all investigators was set to agree on exact anatomic determination prior to image analysis.

The presence and number of median lingual canals

On the axial image, the midline was determined as the line passing through the convexity of genial tubercle to the mental ridge (pogonion). On the sagittal image, five consecutive cuts were taken on each side of the midline; these cuts were used for the assessment of the presence and number of median lingual canals.

RESULTS

Wide range of variations in the lingual foramen and its canals were detected while observing the scans. In males; the most prevalent number of lingual canals was two lingual canals (40%) followed by three lingual canals (28.6%) while the least prevalent number was six lingual canals (2.9%).

In females; the most prevalent number of lingual canals was two lingual canals (48.9%) followed by one canal (27.7%) while the least prevalent number was four lingual canals (4.3%). None of the females had six lingual canals. As regards the whole sample; the most prevalent number of lingual canals was two lingual canals (45.1%) followed by one canal (24.4%) while the least prevalent number was six lingual canals (1.2%) (Table 1 & Fig. 1).

TABLE (1): Descriptive statistics for number of lingual canals in the study participants

Number of lingual canals	Males (n = 35)		Females (n = 47)		Total (n = 82)	
	N	%	N	%	N	%
One	7	20	13	27.7	20	24.4
Two	14	40	23	48.9	37	45.1
Three	10	28.6	9	19.1	19	23.2
Four	3	8.6	2	4.3	5	6.1
Six	1	2.9	0	0	1	1.2

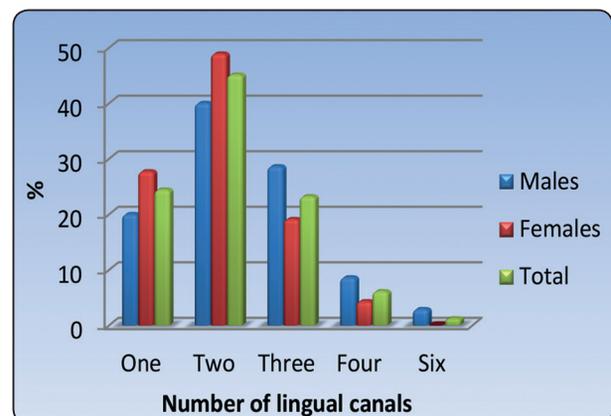


Fig. (1). Bar chart representing distribution of number of lingual canals in males, females and the whole sample

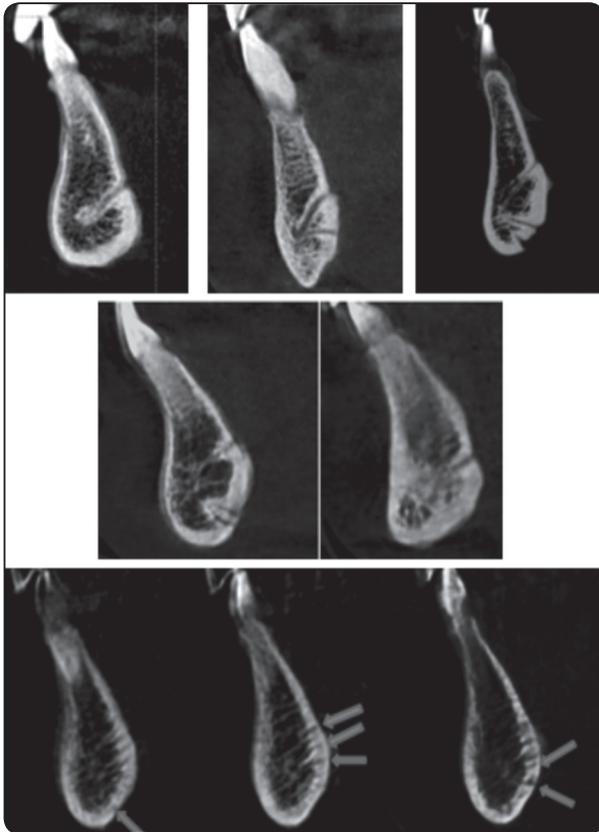


Fig. (2) CBCT images showing morphology of lingual canal

DISCUSSION

Presence of lingual foramina and lingual canals

In this study, upon examining the CBCT scans for the median mandibular region the presence of at least one lingual foramen and canal in all the patients was reported. Our study results support those of *Katakami et al. 2009*²¹, *Babiuc et al. 2011*, *Sheikhi et al. 2012*, *Wang et al. 2015*, *Kumar et al. 2017*, *Bhadouria et al. 2018*, *İşman et al. 2021* & *Jan et al. 2021*)^{5,34,37,23,7,16,19} as their studies had similarly reported at least one lingual foramen in 100% of the examined cases. Approaching almost similar results, *De Andrade Santos et al. 2021*¹⁰ made a research on Brazilian subpopulation including 303 scans, two scans did not show the presence of any foramina, while 301 scans did,

indicating a prevalence rate of 99.3%, same results were reported by *Salinas-Goodier et al. 2015*³⁰ on a Spanish subpopulation.

Some other studies have shown close results as, *Kawai et al. 2007*²² who examined 68 dry Japanese mandibles using CBCT and reported the presence of at least one foramen in 97% of the cases, similarly, *Rathore et al. 2018*²⁹ examined a sample of Indian subpopulation of 100 patients and got same results, also, *Do Carmo Oliveira et al. 2018* made a study on a Brazilian subpopulation including 202 scans and he found the lingual foramen in 97% of the cases examined.

Yet, *Aoun et al. 2017*³ reported that 84 out of 90 CBCT (93.33%) scans made on Lebanese population showed at least one lingual foramen, this difference may be due to ethnicity reason. Moreover *Jacobs et al. 2002*¹⁷ also reported that the foramen was detected in only 82% of the cases that were examined by spiral CT. One possible interpretation for this disagreement is the imaging technique used by Jacobs et al.; as in our study, the thickness cut was set to 0.4 mm and an interval of 0.4 mm between the cuts unlike the 1 mm thickness used by Jacobs et al., which may have masked smaller diameter foramina on the mandibular midline. Another reason for this difference could be due to ethnicity reason.

Number of lingual foramina

In our present study the number of lingual canals ranged from one to six canals, with **24.4%** showing single canal, **45.1%** which was the most frequent showing two canals, **23.2%** showing three canals, **6.1%** showing four canals and only one male patient had six canals **1.2%**.

The study results were in accordance with those of *Sheikhi et al. 2012* on Isfahanian subpopulation, *Choi et al. 2013*⁹ on Korean subpopulation, *Abesi 2015 et al.*¹ on Iranian subpopulation, *Assari et al. 2017*⁴ on Saudia Arabian subpopulation, *Jan et al. 2021*¹⁹ on Indian subpopulation & *De Andrade Santos et al. 2021*¹⁰ on Brazilian subpopulation,

who all noticed that double foramina are the most frequent 52.9%, 40%, 53%, 38.8%, 57.69% and 47.5%, respectively. But these results are in disagreement with the findings of *Kawai et al. 2007*²² on Japanese sub population, *Liang et al. 2009*²⁵ on Belgian population, *Babiuc et al. 2011*⁵ on Romanian subpopulation, *Sekerci et al. 2014*³³ on Turkish subpopulation, *Matthew et al. 2015*²⁸ on Chinese subpopulation and *Bhadouria et al. 2018*⁷ on Indian subpopulation, who reported that single foramina is the most frequent reported finding with percentages of 47%, 41%, 71.9%, 48%, 43% and 65%, respectively. This difference may be due to ethnicity reason or to the limited samples' size of some of these previously mentioned studies.

Compared to our study, some studies reported a significantly high percentage for three lingual canals, such as *Wang et al. 2015*³⁷ (27.7%), *Zhang et al. 2018*³⁹ (30.7%) and *Sanhueza et al. 2018*³² (34.6%). While *Assari et al. 2017*⁴ detected three lingual canals in 26.9 % of the participants. Among other studies less prevalence three lingual canals was reported, where, *Aoun et al. 2017*³ reported only one case (1.1%), *Denny et al. 2016*¹³, two cases (1.7%), *Sanchez-Perez et al. 2018*³¹, four cases (4.08%), and *Xie et al. 2019*³⁸, 21 cases (2.1%) from the total sample.

Interestingly, *Babiuc et al. 2011*⁵, *Sheikhi et al. 2012*³⁴ *Choi et al. 2013*⁹ and *El Dessouky 2016*¹⁴ detected 4 foramina, respectively, 2 out of 36 (3.1%), 3 out of 102 (2.9%), 3 out of 20 (15%) and 3 out of 100 (3%) mandibles assessed. Moreover, five lingual foramina were observed by *Gahleitner et al. 2001*¹³ in a single case out of 32 patients (3%), and six foramina were found in 8.7% of the cases in a study that was conducted by *Demiralp et al. 2017*¹² on the ancient Anatolian population.

In our study comparing the number of canals according to the gender it was found that, in males; the most prevalent number of lingual canals was two lingual canals (40%), which was similar to a study made on Isfahan subpopulation by **Sheikhi**

et. al. 2012³⁴ (47.5%), also, *Salinas Goodier et al. 2015*³⁰ on a Spanish subpopulation reported equal prevalence for both single and double lingual canals (41.6%) for each. On the contrary to our study which stated that the prevalence of single canal was 20%, other studies stated that single lingual canal was the most prevalent in males; *Denny et al. 2016*¹³ (70.2%), *Bhadouria et al. 2018*⁷ (65%) & *De Andrade Santos et al. 2021*¹⁰ (52.9%). Three lingual canals had a higher prevalence than single lingual canals in our study (28.6%), which was a higher prevalence compared to other studies, *Sekerci et al. 2014*³³ (10.6%), *Abesi et al.*¹ 7.5%, *De Andrade Santos et al. 2021*¹⁰ (4.9%), *Jan et al. 2021*¹⁹ (5.77%). While the least prevalent number detected in males was six lingual canals (2.9%) similar to *Wang et al. 2015*³⁷ (2.0%).

On the other hand, in **females**; the most prevalent number of lingual canals was two lingual canals (48.9%), similar results were approached by *De Andrade Santos et al. 2021*¹⁰ (50.3%) & *Rathore et al. 2021*²⁹ (48%). Oppositely, it was stated that single canals had higher prevalence in females by *Denny et al. 2016*¹³ (33%) & *Bhadouria et al. 2018*⁷ (64.7%), which doesn't support our results where the prevalence of one canal was (27.7%). While, the least prevalent number in our study regarding females was four lingual canals (4.3%), nearly similar result was reported by *Wang et al. 2015*³⁷ (2.0 %). Moreover, none of the females had six lingual canals, similarly to *Wang et al. 2015*³⁷, where in his study only six lingual canals were detected in males.

CONCLUSION

From the present work, the following specific conclusions could be reached:

All patients, investigated in the current study, showed at least one lingual foramen; with the most prevalent number of lingual canals being two lingual canals (45.1%).

The comparable gender analysis performed in the current study revealed equivocal findings between males and females regarding number.

From the high prevalence of foramina and canals in our study and being a paramount topic of discussion, the following generic conclusion could be reached:

Determination of the prevalence and the number of median lingual canals before implant surgery in mandibular midline region is crucial as these canals are constant anatomical landmarks, and with the contraption of CBCT, we can depict these canals in great details. CBCT could act as a guide to prevent damage any neurovascular bundles and should be considered before planning any surgical procedures in this area.

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