Determination of The Prevalence and Types of Bifid Mandibular Canal in A Navi Mumbai Population- A CBCT study

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Abstract

Title: - Determination of The Prevalence and Types of Bifid Mandibular Canal (BMC) in A Navi Mumbai Population- A Cone Beam Computed Tomography Study

Introduction: - There is a co-relation between ethnicity and the frequency of BMC and understanding the detailed anatomy of the mandibular canal (MC) is vital for various operational interventions of the mandible. The MC can be identified through various imaging techniques, out of which CBCT is the most reliable one. It is important to note that anatomical variations can exist such as bifid canals, high-riding canals, or canals with different branching patterns. Therefore, a thorough preoperative evaluation using imaging is crucial to accurately identify and understand the specific anatomy of the mandibular canal in each patient.

Methodology: - CBCT scan of 145 participants were assessed for the presence of BMC using Naitoh's classication. The prevalence rates were compared for gender, location and type of bifid mandibular canal.

Results: The incidence of BMC was 9.6%, with males having 12.3% and females having 5.3%. The difference was statistically significant for the location of bifid mandibular canals, with the majority of them being located on the right side. Type I retromolar canal (50%), type II dental canal (35.7%), and type IV buccolingual canal (14.2%) were the most prevalent kinds of BMC observed.

Conclusion: Bifid canal was seen in 9.6% of cases, with the majority of them located on the right side of the jaw. Type 1 was found to be the most common. Even if the rate is modest, it is very important while planning dental procedures.

Keywords: Cone-Beam Computed Tomography, Radiographic Imaging, Bifid Mandibular canal, Mandibular canal variations

Introduction

The mandibular canal (MC) is a crucial anatomical component which is extensively studied due to its significance in dental and surgical procedures. It is seen extending bilaterally in the mandible starting from mandibular foramen to end in the mental foramen and within it, the inferior alveolar nerve (IAN), artery as well as vein are located. There are many variations in course and anatomy of MC. These anatomical modifications can include changes in the position, shape and size of the canal as well as presence of accessory canals or branches.[1]

There are many variations of MC, the bifid mandibular canal (BMC) being one of them. Preoperative imaging, such as CBCT scans, is often employed to accurately identify and evaluate the specific anatomy of the mandibular canals reducing complications and injuries in patients.[2]

The IAN is usually damaged in the mandible. According to the literature and evidence shows that this may be associated with the existance of BMC.

Understanding these constructural variations is essential for dental surgeons, as it helps them anticipate and mitigate potential risks during procedures such as dental implant surgery, disimpactions or mandibular osteotomies.[1] The number of practitioners performing implant surgery has increased over the past 15 years and thus the need to understand relevant anatomy is very important.

Literature has demonstrated that there are racial differences in the incidence and type of BMC. The occurrence was highest in the Korean and Turkish populations, accounting for 52.2% and 75.7% of BMCs respectively.[4,5]

No literature is available on the prevalence of BMC in Navi Mumbai population. Hence our study was aimed at assessing the prevalence and types of BMC in Navi Mumbai population using CBCT.

Materials and methods

This retrospective research was carried out using CBCT collected from various dental colleges and clinics situated in Navi Mumbai. Approval from Institutional Ethics Committee was obtained before conducting the study.

Based on the findings of previous study the prevalence of BMCs was 10.3%.[6] At 95% confidence level and 5% in allowable error, the sample size was based by the formula

$$n = \frac{z^{(2)}pq}{(d)^{(2)}}$$

n = sample size

z = standard normal deviation

p = prevalence

q = 100- p

d = allowable error (5%)

The number of samples were 145.

This study employed CBCT of participants who had undergone pre-operative CBCT imaging for various dental objectives.

Inclusion criterion

- The study included the CBCT scans of patients of age 15 years and above.

Exclusion criteria

- CBCT images from the research were eliminated if they did not demonstrate any portion of the mandible, that had insufficient accuracy of the region of interest and had any cysts, tumors, bone malformations or surgery on the ramus or mandibular body.

Image analysis with CBCT

NNT iRYS viewer software was used in this study to reformat CBCT images.With the use of this program, it is possible to analyse the mandible in its entire form while simultaneously seeing panoramic, cross-sectional, axial as well as 3D renderings of the mandible. Both the sides of the mandible were studied. Panoramic views, sagittal, axial and coronal of the CBCT images were assessed. The image density and contrast were modified in order to enhance the visibility. For an in-depth analysis of the mandibular canal and its changes, modifications were made using a thickness slice that was roughly 1 mm and a distance that was roughly 0.3 mm.[6]

A nerve marking instrument was used to trace the path of the inferior alveolar nerve. The BMC was marked with a yellow hue, whereas the main mandibular canal was marked with a red tint. In order to enable simultaneous observations in the cross-sectional, coronal and axial views, this tracing process was carried out in the panoramic view.[6]

By using these techniques and resources, we were able to precisely assess the existence and anatomy of the BMC using CBCT. With a focus on the path and branching patterns of the IAN, this method gave researchers a thorough grasp of the mandibular canal's morphology and variation.[6]

The study used particular approaches to make sure that the MC could be seen clearly. The canal was first chosen as the reference line's center of rotation for multiplanar reconstruction. This adjustment allowed for optimal alignment and orientation of the images for evaluation.[6]

The CBCT sections were then horizontally rotated, with varied amounts of buccolingual (side to side) and anteroposterior (front to back) movement of the center. The photos were altered in order to improve the mandibular canal's clarity and to find any possible bifid mandibular canals.[6]

These canals needed to be evident on all reformatted pictures, including the panoramic, coronal and sagittal portions to confirm its genuine presence. This comprehensive assessment ensured a thorough evaluation and confirmation of the BMC. BMCs were further classified using the Naitoh et al. classification.[7]

NAITOH'S CLASSIFICATION

TYPE I (Retromolar canal type)	The mandibular canal splits into the retromolar canal in the mandibular ramus area, which travels forward to the retromolar region.
TYPE II (Dental canal type)	The dental canal branches off from the mandibular canal in the mandibular ramus area and travels forward until it reaches the molar root.
TYPE III (Foward canal type)	(a) Forward canal without confluence: the forward canal splits off from the mandibular canal at the mandibular ramus region and it travels forward to the second molar region. (b) Forward canal with confluence: The forward canal, which splits off from the main mandibular canal in the mandibular ramus, travels anteriorly before joining it.
TYPE IV (Buccolingual canal type)	(a) Buccal canal: The buccal canal runs bucco-inferiorly after splitting off from the mandibular canal in the mandibular ramus. (b) Lingual canal : The lingual canal travels lingually before penetrating the lingual cortical bone after splitting off from the mandibular canal in the mandibular ramus.

Statistical analysis

The study used a Microsoft Excel spreadsheet to record information on the number of images, age, gender, the existence (sides) and type of BMCs. The data were analyzed using SPSS software, version 24.

The incidence of the BMC was compared by location (right or left), gender and type using the Pearson's Chi-square test and Mann-Whitney U test.

Results

A prevalence of 9.3% was determined for the current study based on the 145 CBCT pictures that were selected, 14 of which showed the presence of BMC.

The BMC was observed in 11 (12.35%) males and 3 (5.3%) females. Gender differences were not statistically significant. [Table 1].

Table-1: Gender-specific incidence of the BMC

Gender	Present		Absent	
	n	%	n	%
Male	11	12.35	78	87.6
Female	3	5.3	53	94.6
Total	14	9.6	131	90.3

Six (42.8%) of the 14 (9.3%) BMC were seen on the right side, (35.7%) five were on the left side, and three (21.4%) were bilaterally present. The difference was statistically significant (P<0.001) [Table 2].

Table 2: BMC prevalence based on locations.

Gender	Present		Absent	
	n	%	n	%
Right side	6	42.8	8	57.2
Left side	5	35.7	9	64.3
Bilateral	3	21.4	11	78.6

When looking at the 14 bifid mandibular canals found, type I retromolar canals were the most common (7 cases, or 50%) followed by type II dental canals (5 cases, or 35.76%), and type IV buccolingual canals (2 cases, or 14.2%). According to the Chi-square test, the results are not statistically significant. (P = 0.49). Various BMC types were observed to be evenly present on both the sides.

Table 3: The frequency of various kinds of BMC.

Classification of bifid canals	No	Rate
Type I	7	50
Type II	5	35.7
Type III with confluence without confluence	0	0
Type IV Buccal Canal Lingual Canal	2	14.2

Discussion

The mandibular nerve, also known as the V3 branch of the trigeminal nerve, exits through the foramen ovale, is situated in posterior part of greater wing of sphenoid bone. Mandibular nerve exits the skull via the foramen ovale, innervating various regions of the face and oral cavity and coming to an end at the mental foramen.[8]

During embryogenesis, the mandible is developed from the first pharyngeal arch. Neural crest cells migrate and converge forming the mandibular nerve and related structures, which in turn establish the mandibular canal. The mandibular nerve extends into growing jaw and finally passing into the mandibular canal. These canals converge into a single canal during the fetal growth phase of bone remodeling and apposition. A structural difference like a trifurcation or bifurcation occurs when these three canals do not completely fuse.[9]

In many cases, the most frequently used injection location is superior from the region where bifurcation is present in the mandibular ramus. Therefore, local anesthesia can be administered using the Akinosi approachor, the Gow-Gates technique where the local anesthetic solution is injected just before the area where the mandibular nerve splits in two. Some authors have reported failures to achieve mandibular anesthesia and on radiographic imaging it revealed the presence of a BMC.[10-13]

Since last 15 years, the number of practitioners performing implant surgery has increased. Hence taking necessary precautions to avoid damaging the bifid mandibular canal and other vital structures is a must. By carefully evaluating the radiographic images and being aware of the possibility of bifid canals, dental practitioners can plan their surgical approach accordingly.

Panoramic radiographs provide an overview of the mandible, allowing identification of differences in the mandibular canal. Furthermore, they may not offer specific information on the exact path and relationship of the branches inside the bifid canal. CT and CBCT imaging techniques offer more precise and detailed visualization of the mandibular canal. These techniques allow for 3-D reconstructions and cross-sectional views, giving a thorough evaluation of the bifid mandibular canal's anatomy, course and position. CBCT, specifically has become increasingly popular in dental and maxillofacial imaging due to its relatively lower radiation dose and high-resolution imaging capabilities.[12]

Bifid mandibular canal incidence was reported by Nortje' et al.[8] as 0.9% (33/3612), while Durst and Snow[9] found an incidence of 8.3% (85/1024). It should be noted that the number of BMC occurrences documented in radiological imaging varies greatly. (0.08-8.3%) and no consensus has been reached.[14]

Geographical and racial differences in the incidence and type of BMCs have been reported. As no studies have been reported in the Indian population, this study was undertaken.

It was observed that the prevalence rate of BMC was 9.6%.The BMC was observed in 11 (12.35%) males and 3 (5.3%) females. Statistically no significant difference was found where gender is concerned (Table 1). This study was in accordance with the study done by Nithya et. al, reporting a prevalence rate of 10.3% with no statistically significant difference between genders.[6] However, our study was not in accordance with the study done by Langlais et al[(15)] who reported an incidence of 0.95% and reported a greater incidence of BMCs amongst women (1.03%).

The majority of the canals in our study were found on the right side of the jaw (Table-2). Orhan et al.[17] and De Freitas et al.[18] both found a greater frequency of bifid mandibular canal on the right side.

In our study, we have used Naitoh's classification[7], according to which the most frequently observed type of BMC was type I retromolar canal (50%), followed by type II dental canal (35.7%) and type IV buccallingual canal (14.2%).

Abbas et al. applied the same categorization method and found that forward canals are the most common (1.2%), with retromolar canals being the least common (0.14%). Because of differences in data and geographical location, the stated prevalence rates of each form of bifid mandibular canal were not completely similar amongst authors.[18] Shen et al. discovered that 32.4% of bifid mandibular canals were in a position suitable for dental implant insertion. As a result, understanding the occurrence, favored location and structure of the BMC is critical.[19]

Limitation of the study are that various morphological alterations of the MC were not studied and the sample size was less.

Conclusion

The diagnosis and configuration of the BMCs are indeed important for avoiding post-surgical and anesthetic complications. Its variations can pose challenges during dental procedures, such as dental implant surgeries or surgical extraction of third molar. CBCT is a recommended imaging technique for evaluating bifid mandibular canals in detail. Several studies have found that CBCT has a greater sensitivity and specificity in detecting BMCs.

To further enhance our understanding of bifid mandibular canals and to optimize treatment planning, additional studies with greater sample would be beneficial. These studies could help establish the prevalence of BMCs in different populations and provide more comprehensive data on their anatomical configurations. This information would be valuable for dental professionals to improve their diagnostic skills and minimize complications during surgical procedures involving the mandibular canal.

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