Prevalence of bifid mandibular canal and its relationship with third molar in Indian population: A retrospective analysis

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Abstract

Purpose: The location, configuration, and variations of mandibular canal such as bifid/trifid/double mandibular canals play a significant role in performing surgical procedures in the mandible. The study was aimed to assess the prevalence of bifid mandibular canals using cone beam computed tomography (CBCT) images.

Materials and Methods: A retrospective study on CBCT images of full skull or mandible of patients, taken during the period from May 2014 to April 2016, was carried out. Images with any gross pathology involving mandible were excluded. CBCTs were examined by a single examiner for presence, type of bifid mandibular canal, and the relationship of bifid mandibular canal with the third molar.

Results: A total of 408 CBCTs were examined, out of which 23 exhibited bifid mandibular canal with the prevalence of 5.63%. Type 2BC was the most common type of bifid mandibular canal. All the CBCTs showing Type 1U and 1B bifid mandibular canals, 33.3% of Type 2UC and 25% of Type 2BC bifid mandibular canals exhibited Class B relationship with the third molar.

Conclusion: Suspicion of bifid mandibular canal on a screening orthopantomogram should be confirmed by CBCT. Assessment of the type of bifid mandibular canal will help in treatment planning of mandibular surgical procedures.

Keywords: Accessory mandibular foramen, accessory mental foramen, bifid mandibular canal, cone beam computed tomography, molar third

Introduction

The mandibular canal is usually a single channel which is enclosed by bone. It is referred to as bilateral single structure that curves downward and forward from mandibular foramen toward the mental foramen. It encloses the inferior alveolar nerve and associated vessels that give rise to dental plexus within the canal in respective areas to supply each tooth of the lower jaw. The inferior alveolar nerve enters the mandibular canal through mandibular foramen on the medial aspect of the ramus and exits through the mental foramen on the lateral aspect of the body of the mandible.1

Radiographically, mandibular canal may appear in varying shapes such as oval, circular, or pyriform, showing a radiolucent dark ribbon between two radiopaque lines casted by lamellar bone that bounds the canal. The edges of mandibular canal demonstrate different radiographic patterns that may range from alternate radiopaque and radiolucent bands to continuous radiopaque lines depending on the number and distribution of the osseous trabeculae around the mandibular canal.1

The location, configuration, and variations of mandibular canal play a significant role in performing surgical procedures in the mandible. Bifid mandibular canal is one of the anatomical variations of mandibular canal that is unusual but not rare. The bifid canals may contain only accessory blood vessel or an accessory neurovascular bundle.2 Certain clinical implications are associated with bifid mandibular canal such as inadequate anesthesia being the most common complication followed by bleeding, paresthesia, traumatic neuroma during impacted mandibular third molar removal, implant placement, mandibular fracture reduction, denture fabrication, root canal treatment, etc.3 After the inferior alveolar nerve block, if the anesthesia occurs only around the site of injection but not the lip or chin, then it is attributed to incorrect anesthetic technique. However, with the inferior alveolar nerve block, if the anesthesia occurs only in the lower lip and chin but not the teeth, it is indicative of the presence of bifid mandibular canal with accessory neurovascular bundle.2 In a present scenario, many dental professionals are still unaware of this anatomical...
variation although it can be recognized on panoramic radiograph. The presence of bifid mandibular canal can be identified on orthopantomogram (OPG) by a triangular island of bone formed by cortical outlines of the canals joining together with the apex of triangle representing the root of separation of both the canals.\(^1\)

The present study was aimed to assess the prevalence of bifid mandibular canals using cone beam computed tomography (CBCT) images with the objectives to evaluate the variation in the mandibular canal with relation to gender and side predilection, type of bifurcation, and its association with the mandibular third molar.

**Materials and Methods**

This retrospective study was carried out in the Department of Oral and Maxillofacial Surgery and Oral Radiology, FDS, RUAS, Bangalore. The ethical clearance was obtained from the institutional review board for conduction of the study. The samples included in this study were CBCT images of full skull or mandible alone that was obtained between May 2014 and April 2016 from the college database. Images showing any gross pathology in the mandibular ramus and angle region, obscuring the area of study, were excluded.

Technical parameters of all the CBCT scans were set at 90 kVp, 6.3mA. Database of CBCT images comprised individuals of different age groups and gender. CBCT assessment was done by a single calibrated examiner using CS three-dimensional (3D) imaging software. Assessment was performed in the presence of adequate lighting in three spatial planes, i.e., axial, coronal, and sagittal sections. Sagittal and axial cuts, along with 3D reconstruction allowed the best observation of accessory mandibular and/or mental foramen. Coronal and sagittal cuts provided the best observation of mandibular canal bifurcation. Image density and contrast was adjusted digitally for easy and comfortable viewing. CBCT images were categorized on the basis of gender and side, morphology of bifurcation according to Langlais et al.\(^5\) [Figure 1] and relationship of bifid mandibular canal to third molar roots according to Correr et al. [Figure 2].\(^3\)

**Statistical analysis**

Statistical software SPSS version 20.0 was used to calculate descriptive data and to perform Chi-square test for data analysis.

**Results**

The study sample included CBCT images of 408 patients, out of which CBCT images of 23 patients (5.63%) demonstrated bifid mandibular canal. 5 patients showed bifid mandibular canal on the left side, 8 showed on the right side, and 10 demonstrated bilateral presence of bifid mandibular canal [Graph 1]. Of 23 samples, 14 were males while 9 were females, thus, indicating male predilection in our population [Graph 2]. Male-to-female ratio was found to be 61:39.

Among 23 CBCT images showing bifid mandibular canal on radiographic assessment, 34.78% were Type 2BC bifid mandibular canal (8), 13.04% were Type 1U, 1B, 2UR, 2UC, and Type 4 bifid mandibular canal (3 each). None of the samples exhibited Type 2BR and Type 3 bifid mandibular canal (0). Relationship of bifid mandibular canal with the roots of the third molar was seen in 39.13% (9). In all the CBCTs showing Type 1U and 1B, 33.33% of Type 2UC canal and 25% of Type 2BC bifid mandibular canals exhibiting bifid mandibular canals, there was Class B relationship with the roots of the third molar. All the images of Type 1B and 2BC, demonstrating Class B relationship, showed it on both the sides [Graph 3].

Occurrence of bifid mandibular canal is unusual but not rare with its prevalence being 5.63% in the present study.

**Discussion**

The inferior alveolar nerve is directed from lingual surface of mandibular ramus toward different tooth regions and develops

[Graph 1: Relationship of bifid mandibular canal with side involved]
in three segments which fuses together to innervate incisor, canine and premolar, and molar region. At around 7 weeks, intramembranous ossification begins at the region where the inferior alveolar nerve divides into mental and incisive branches and extends posteriorly along the lateral border of Meckel’s cartilage producing a gutter around the inferior alveolar neurovascular bundle. With this development, there is a fusion of all the three segments of the nerves. However, an incomplete fusion of these segments during this period may result in bifid or trifid mandibular canal development during intrauterine life.\(^6\)

Knowledge of anatomy and variations of mandibular canal is imperative in dentistry that aids in prompt diagnosis. There are different diagnostic modalities that help in identifying and confirming the presence of bifid mandibular canals ranging from two-dimensional (2D) imaging such as OPG to 3D imaging such as computed tomography, CBCT, and magnetic resonance imaging. The panoramic X-rays are the routinely advised diagnostic radiographs for trauma evaluation, position of third molars, extensive diseases, suspected large bony lesions, stage of tooth development (especially in mixed dentition), retained tooth or root tips, and any developmental anomalies, etc. Since OPG is a 3D image, it may lead to some diagnostic errors in interpretation. These errors include superimposition of bony structures, inadequate position of the patient, distortion of the radiograph and magnification of the device, bony condensation produced by mylohyoid ridge in the floor of the mouth, or anatomy of mylohyoid groove.\(^3,7\) Thus, OPG aids in identifying the suspected bifid or trifid mandibular canals but not the confirmation. Due to superimposition of canals, buccal/lingual bifid canals cannot be identified in the panoramic radiographs. With the advent of CBCT, it is now possible to assess in all the three dimensions that aids in elimination of the above errors with an added advantage of 3D reconstruction. CBCT scans provide clearer images of the mandibular canal when compared to digital panoramic radiographs as they are free of overlap and other problems inherent to panoramic radiographs.\(^3\)

In the present study, CBCT images of 23 patients demonstrated bifid mandibular canal out of 408 CBCT images accounting for the prevalence of 5.63%. Males were found to be predominant over females for the presence of bifid mandibular canal. There was no predilection for side of the jaw associated with bifid mandibular canal. Among 23 CBCT images with the

![Graph 2: Relationship of bifid mandibular canal with gender](image)

![Graph 3: Relationship of bifid mandibular canal with roots of the third molar](image)
presence of bifid mandibular canals, majority were Type 2BC bifid mandibular canal accounting for 34.78% followed by Type 1U, 1B, 2UR, 2UC, and Type 4 bifid mandibular canal accounting for 13.04% each. None of the images exhibited Type 2BR and Type 3 bifid mandibular canal. Relationship of bifid mandibular canal with the roots of the third molar was seen in 39.13% images. In all the CBCTs showing Type 1U and 1B bifid mandibular canals, 33.33% of Type 2UC canal and 25% of Type 2BC bifid mandibular canals exhibited Class B, i.e., close relationship with the roots of the third molar. All the images of Type 1B and 2BC demonstrating relationship with the roots of the third molar showed Class B relationship on both the sides.

Initially, published studies by Lara et al.,[1] Langlais et al.,[5] Nortjé et al.,[8] Sanchis et al.,[9] and Singh et al.[10] using panoramic radiograph on bifid mandibular canal reported the prevalence of 5%, 1%, 1%, 0.35%, and 4.3%, respectively. Recent studies employed CBCT images where Rashsuren et al.,[11] Yang et al.,[12] and Orhan et al.[13] found the prevalence as high as 22.6%, 31.1%, and 46.5%, respectively, compared to the prevalence of 5.63% found in the present study using CBCT images. Sanchis et al.[9] reported female predilection; however, in the present study, male predilection was found.

There are various classifications for bifid mandibular canals proposed by different authors such as Langlais et al.,[5] Nortjé et al.,[8] and Naitoh et al.[14] In the present study, Langlais et al., classification was utilized to designate the type of bifid mandibular canal since it was the most cited classification system in the literature.

Lara et al., in 2003,[1] found majority of Type 1U followed by Type 1B, 2UR, and 2BR canals. Correr et al., in 2013,[5] found majority of bifurcations to be Type 1U showing Class C, i.e., intimate relationship with the roots of the third molar. However, in the present study, Type 2BC was the most common bifurcation seen followed by Type 1U, 1B, 2UR, 2UC, and Type 4 canal. There were no images demonstrating Type 2BR bifurcation. All the images of Type 1U and 1B canals and few images of Type 2UC and 2BC canals depicted Class B relationship with the roots of the third molar.

A study by Grover et al.[15] presented the evidence of missing inferior alveolar nerve within the accessory canal with only blood vessel within it. They also observed complete anesthesia after the nerve block in spite of radiographically confirmed bifid mandibular canal. Contradictory to the study by Townsen and Lew[2] presented a case report with the evidence of the presence of neurovascular bundle within accessory canal, where there was failure in achieving adequate anesthesia after nerve block in radiographically confirmed bifid mandibular canal. It was supported by Fukami et al., in 2012,[16] who confirmed the presence of neurovascular bundle on cadaveric mandible, in CBCT proven bifid mandibular canal, by gross anatomical and
histologic methods. Clinically, most often inadequate anesthesia is experienced in cases where there is accessory mandibular foramen and rarely with bifid mandibular canal.[4]

A single case found in a study conducted by Yang et al.,[12] demonstrating bifid mandibular canal in CBCT images of a father and son gave rise to a query of any genetic correlation which needs to be evaluated in further studies.

Limitation of the present study is the lack of radiographic and clinical correlation as it was a retrospective study. In future, a prospective clinical study needs to be conducted to investigate on the genetic predisposition and the correlation of radiographic data with the clinical findings during/after performing the surgical procedures on mandible.

It can be concluded that a sound knowledge of anatomical variation of mandibular canal plays an important role in avoiding perioperative and post-operative complications during third molar removal, implant placement, fracture reduction, denture fabrication, root canal treatment, etc., thus promising the success of surgical procedures. Suspicion of bifid mandibular canal on a screening OPG should be confirmed by CBCT as a diagnosis has evolved into a totally new concept. Based on the results of present study, a close relationship between third molar and bifid mandibular canal exists most commonly with Type 1 bifid canals.

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References