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Research Article

Prevalence of Accessory Mental Foramen in Indian Population: A Retrospective CBCT Study

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Abstract

Statement of the Problem: Accessory mental foramen (AMF), is a relatively rare anatomic variation found in the vicinity of the mental foramen. AMF generally contain branches of major blood vessels and nerves and inadvertent damage to these vital structures passing through AMF during a surgical procedure in the premolar and molar region could result in a plethora of neurovascular complications both during surgery and post-surgery. Hence, knowledge of accessory mental foramen (AMF) is necessary while performing surgical procedures around the mental foramen (MF) such as, implant placement and endodontic surgeries. Very few studies have been done on AMF in the Indian population warranting further investigation.

Purpose: To determine the prevalence and characteristics of AMF in a subset of Indian population using Cone beam computed tomography (CBCT).

Materials and Methods: A retrospective study was done with 200 CBCT images which were retrieved from the archival records. The axial and coronal image sections were used for the detection of AMF. The prevalence of AMF was evaluated by two observers. The age and gender distribution and the most common side of occurrence AMF was observed. The position of the AMF with respect to MF, the surface area of AMF and the distance between AMF and MF were measured on sagittal sections.

Results: Of the 200 images examined, 54 (27%) presented with 71 AMF. No significant difference was noted between the age and gender distribution of AMF (chi square test, p- 0.1531, p = 0.7503 respectively). Most of the AMF occurred on the right side (65.21%) of the AMF and MF were measured on sagittal sections. The surface area ranged from 0.16 - 2.11 mm^2 with a mean of 1.05 mm^2 ± 0.28 mm^2. The distance of the AMF to the MF in horizontal plane (mean- 5.08 mm) was greater than the distance in vertical plane (mean- 1.8 mm).

Conclusion: A considerable number of individuals (27%) in the present study presented with AMF. It is important for a radiologist to possess adequate knowledge on the presence and frequency of these accessory foramina and incorporate them in interpretation of reports to alert the surgeon.

Keywords: Accessory Mental Foramen; Mental Foramen; Cone Beam Computed Tomography

Introduction

The mental foramen is solitary, circular, or elliptical in shape and is present bilaterally on the lateral surface of the mandible. It is generally found inferior to the interproximal region of the mandibular first and second premolar. The foramen opens in a superior-posterior direction [1-7].

In the vicinity of the mental foramen, the accessory mental foramen (AMF) is a rare anatomic variation [2] that may be present and may be termed as double or plural mental foramen [8,9]. A few studies have examined the contents of the accessory mental foramina, although consensus has not been reached [10]. It has been reported that either a branch of mental nerve enters or exits the mandible or a branch of an artery (buccal, submental, facial) enters the mandible through the accessory foramina [8].

The AMF are defined as smaller buccal foramina with continuity to the mandibular canal (MC) [11,12]. In a CT-based study accessory foramina have been classified according to their continuity with the mandibular canal. According to these reports, an accessory foramen showing a connection with the mandibular canal was defined as accessory mental foramen (AMF), and an accessory foramen showing no connection with the mandibular canal was defined as a nutrient foramen [1,12,13]. AMF normally occurs singly, but the number can range from 1 to 3 foramina per side [3,12-15].

The knowledge and identification of the AMF is important in surgical procedures performed around the mental foramen such as, implant placement [16], endodontic surgeries [12,17] etc. Inadvertent damage to these vital structures could result in postoperative complications such as neurosensory alteration in the chin and lower lip [16]. Also, damage to vessels may result in bleeding during the surgical procedure [10]. Further, if the accessory mental nerve is not recognized and excised during neurectomy procedures in cases of trigeminal neuralgia, it may result in failure of the procedure [2]. A few researchers are of the opinion that accessory foramina play a role in tumour invasion into the cancellous bone from lingual and buccal aspects of the mandible, especially in irradiated mandibles due to reduction in barrier mechanism of the periosteum [18]. There have been reports of failure of analgesia in the mandible after blockage of the inferior alveolar nerve. This may be due to additional sensory innervations of the mandible via the accessory foramina mostly from the branches mylohyoid and facial nerve, although several other nerves may also be involved [19].

Conventional radiography such as periapical and panoramic radiographs provides limited information with regard to identification of accessory mental foramina because the long axis of an AMF is generally less than 1.5 mm, and it is difficult to recognize this structure with two-dimensional techniques [1,5,9,12].

Although CT has been recognized as a valuable adjunct to implant surgery, it has limited utility because of high cost, increased radiation dose and complicated implant software. However, observations of AMF smaller than the usual size and anatomic relationship among AMF, MF, and mandibular canal are difficult with the resolution obtained using a spiral CT [12].

Cone-Beam Computed Tomography (CBCT) is a relatively new imaging modality of choice for visualizing osseous structures in the maxillofacial region. It offers multiplanar, 3 dimensional images with distinct advantages over CT such as higher spatial resolution, lower dosage, accuracy and is relatively cost effective [20]. The field of view can also be adjusted depending on the area of interest which minimizes tissue irradiation by exposing only the specific area of interest [20-23]. High-resolution images of CBCT for dental use would be available for detection of the AMF and investigation of intraosseous course of the accessory branch of mandibular canal between the mandibular canal and AMF [1].

In studies conducted on AMF across the world, a prevalence as high as 30% has been found.

In India, only a handful of studies have been done on AMF, and the prevalence has been found to vary between 5.5 to 13%. Owing to the diverse, ethnic and geographical variations in the subcontinent, a lot more studies are required to gain an insight on the prevalence of AMF in the Indian population.

With the above background, the present study was designed to determine the prevalence of accessory mental foramina in Indian population using Cone Beam Computed Tomography.

Materials and Methods

This retrospective study included a total of 200 CBCT images retrieved from the archival records from a CBCT diagnostic center. A prior written consent had been obtained from all subjects before CBCT examination for usage of their data for future research purposes. The study was approved by the ethical committee of the institution.

Images of subjects below 18 years of age, images with pathologies such as cysts, tumors, osteomyelitis etc and those with evidence of fractures in the premolar and molar region were excluded. Images showing errors and artifacts obscuring visibility of structures in the mandible were also excluded from the study. The AMF in which the long axes measured less than 0.5 mm were excluded. Also, the AMF which did not show connectivity with the mandibular canal were excluded.

Image acquisition

The CBCT images were obtained using the three dimensional (3D) Kodak 9300C CBCT machine. The following parameters were used; tube voltage of 180 Kvp, tube current of 10 mA, exposure time of 14 secs and a cylindrical shaped field of view (FOV) measuring 14 x 17 mm with avoxel size of 90 microns. A single 360-degree scan was used.

The sagittal, coronal and axial sections of image were reconstructed from the projection data. The thickness and the distance between image slice was 1 mm. The contrast and brightness of all the images were kept at a constant value for uniformity during image analyses. All images were assessed under optimal viewing conditions with appropriate image viewing software (Carestream 3D imaging software).

The axial images were basically used for the detection of accessory mental foramina, and their presence was confirmed on the coronal sections. The presence of AMF was evaluated by two observers. It was found that there was a good intraobserver and interobserver agreement (Kappa value 0.9049, 0.8997 respectively, p = 0.00001*), hence the observations made by the second observer was made use for further measurements of the AMF.

The position of the AMF with respect to the mental foramen was assessed on the para-panoramic sections. The position of AMF was categorized as anterior, antero-superior, antero-inferior, posterior, postero-superior, and postero-inferior, inferior and superior as shown in figure 1.

Figure 1: Schematic diagram of the position of AMF in relation to MF. S- Superior, AS- Anterosuperior, A- Anterior, AI - Anteroinferior, I- Inferior, PI- Posteroinferior, P- Posterior, PS- Posterosuperior.

The distance between AMF and MF was also measured on the para-panoramic section. For AMF located in the following positions, namely anterior, antero-inferior, posterior, postero-superior, postero-inferior positions, the distance between AMF and the mental foramen was measured in the horizontal plane as shown in figure 2. For AMF positioned either superior or inferior to the mental foramen, the distance between them and MF was measured in the vertical plane as shown in figure 3.

Figure 2: Schematic diagram representing measurement of distance between AMF and MF in horizontal plane.

Figure 3: Schematic diagram representing measurement of distance between AMF and MF in vertical plane.

The measurements of short and long axes of the MF and AMF were also performed on the para-panoramic sections. With the help of these measurements the surface area of MF and AMF was calculated using the formula a/2 x b/2, where π = 22/7, a = long axis and b = short axis.

The data obtained was tabulated and subjected to statistical analyses as follows: The difference in prevalence of AMF with regard to age, gender and side of the mandible was assessed by Chi square test. Comparison of mean surface area of mental foramen with and without AMF was assessed by t test. A p value less than 0.05 was considered to be statistically significant.

Results

Of the 200 images examined, 54 subjects (27%) presented with 71 AMF. Of the 400 sides examined, 64 sides presented with AMF. Of the 64 sides with AMF, 54 sides presented with 1 AMF, 4 sides with 2 AMF and 1 side each with 3 and 4 AMF.

The age of the subjects who presented with AMF ranged from 18 years to 67 years with the mean age of 45.5 years. The distribution of subjects presenting with AMF is elaborated in table 1 (Chi-square test, p = 0.1531).

Age Groups	Subjects examined (n)	Subjects presenting with AMF (n)	Percentage (%)
18 - 30	45	10	22.22
31 - 40	28	8	28.57
41 - 50	37	14	37.84
51 - 60	47	10	21.28
61 - 70	34	12	35.29
> 71	9	0	0.00
Total	200	54	27.00
Chi-square test, p = 0.1531			

Table 1: Age distribution of subjects presenting with AMF.

Of the 54 subjects presenting with AMF, 26 (48.2%) were females and 28 (52.8%) were males. There was no significant gender difference (Chi-square test, p = 0.7503).

Of the 54 subjects presenting with AMF, 46 subjects (85.18%) presented with unilateral AMF as compared to 8 subjects (14.81%) presenting with bilateral AMF. Of the 46 subjects presenting with unilateral AMF, 30 subjects (65.21%) presented AMF on the right side of the mandible and 16 subjects (34.78%) on the left side. A significant difference was noted with regard to the distribution of AMF on the right and left sides of the mandible (Chi-square test, p = 0.00012*) (Graph 1).

Graph 1: Distribution of subjects based on unilateral and bilateral presence of AMF.

Out of 54 subjects with AMF, 43 subjects (79.63%) presented with single AMF, followed by 7 subjects (12.96%) with 2 AMF, 3 subjects (5.56%) with 3 AMF and 1 subject (1.85%) presented with 5 AMF (4 AMF on the left side and 1 AMF on the right side) (Figure 4). A significant difference was noted among the subjects presenting with varying number of AMF (Chi-square test, p = 0.00001*).

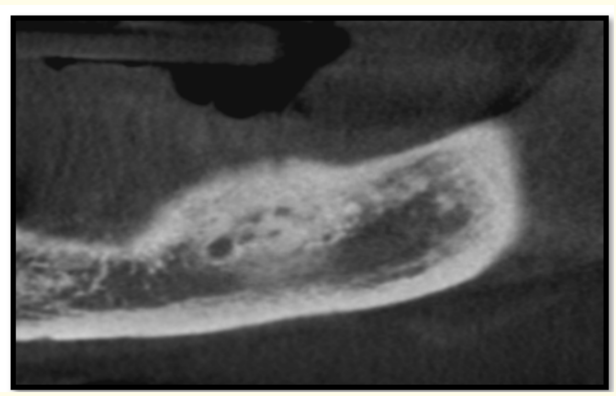
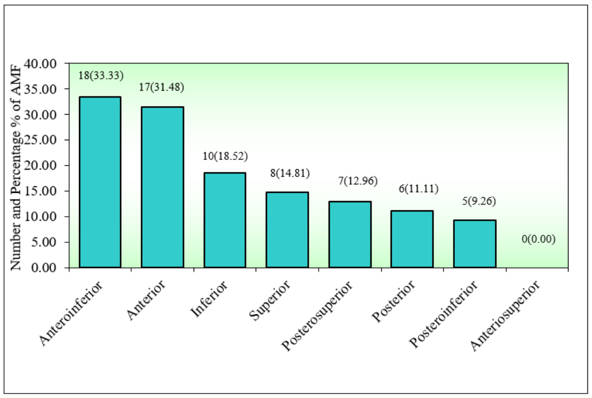


Figure 4: A sagittal CBCT section showing 4 AMF (arrow) on the left side of the mandible posterosuperior to the MF (arrow head).

Of the 71 AMF, 18 (33.33%) were noted in the antero-inferior position with respect to the MF, followed by 17 (31.48%) on the anterior and least i.e., 5 (9.26%) were present on the postero-inferior position (Graph 2).



Graph 2: Distribution of subjects based on the location of AMF in relation to mental foramen.

The distance between AMF (for those located in the anterior or posterior to the MF) and the MF in the horizontal plane ranged from 0.6 - 12.6 mm with a mean of 5.08 mm (Table 2).

Position of AMF in relation to MF	Range (mm)	Mean (mm)	SD
Anteroinferior	1.5 - 12.6	7.64	3.49
Anterior	1 - 9.1	4.13	2.89
Posteroinferior	0.8 - 5.7	3.82	0.89
Posterior	0.6 - 9.1	3.80	3.57
Posterosuperior	2.3 - 4.5	2.77	2.04
	Total	5.08	3.46

Table 2: Mean distance of AMF from MF in the horizontal plane.

The distance between AMF (located inferior/superior to mental foramen) and MF in the vertical plane ranged from 0.6 - 4.9 mm with a mean of 1.88 mm (Table 3).

The surface area of AMF ranged from 0.16 - 2.11 mm^2 with a mean of 1.05 mm^2 $\pm$ 0.28 mm^2.

Position of AMF-MF	Mean (mm)	SD
Superior	3.82	1.50
Inferior	0.89	0.67

Table 3: Mean distance of AMF from MF in the vertical plane.

The surface area of MF with AMF ranged from 1.88 - 34.96 mm^2 a mean of 10.76 mm^2 and SD of 5.50 mm^2 and the surface area of MF without MF ranged from 1.88 - 43.32 mm^2 with a mean of 10.79 mm^2 and SD of 5.08 mm^2. No significant difference was noted between the mean surface area of MF, with and without AMF. (t- test, p= 0.9677) (Table 4).

Surface Area of MF	Mean (mm^2)	SD	t-value	p-value
With AMF	10.76	5.50	-0.0405	0.9677
Without AMF	10.79	5.08		

Table 4: Comparison of mean surface area of mental foramen with and without AMF.

Discussion

An accessory foramen on the buccal posterior aspect of the mandible in the vicinity of the mental foramen is known by several names such as, double, plural, multiple or accessory mental foramen (AMF) [8,9]. A few researchers use the term accessory mental foramina exclusively for those which on imaging show continuity with the mandibular canal [1,12,13]. However, this has been contradicted by another study which detected the buccal perimandibular neurovascularisation using CBCT and gross anatomy [8,13].

The reason for the occurrence of AMF is not well understood, although the following has been proposed. The formation of mental foramen is incomplete until the 12th week of gestation, when the mental nerve separates into several fascicules at that site. It has been suggested that the separation of mental nerve earlier than the formation of the mental foramen could result in the occurrence of the accessory mental foramen [13,24,25].

The recognition and importance of accessory mental foramina in the mandible has risen in the last two decades with the increased usage of advanced imaging techniques such as CT and

CBCT for the assessment of anatomical structures in the maxillofacial region. These modalities provide excellent quality multiplanar and three-dimensional images which help assist in better surgical management of the patient [20]. However, CBCT has distinct advantages over CT namely, higher spatial resolution, lower dosage and is relatively cost effective [20-23].

The incidence of AMF varies among different ethnic groups and races. On comparison of the mandibular neurovascularization in Neolithic, Medieval and 19 - 20th century mandible samples, it has been noted that neurovascularization is becoming more complex with time [26].

A study on AMF in 81 human populations from around the world demonstrated a higher incidence (20 to 30%) in Central Asia and Sub-Saharan Africa and lower incidence among European, South Asian, East and South-East Asian, Western Oceania, and South America [27]. 3.8% in Bulgarian [28] and 7% in Polish population [29]. In the Indian population, varying incidences of AMF have been reported: 5.5% in South India [30], 6.6% in Gujarat [31], 13% in Lucknow, Uttar Pradesh [32], 12% in Aurangabad [33]. An incidence of 27% was found in the present study. It was relatively higher as compared to other Indian studies. The diverse ethnicity of the Indian population could be attributed to this variation.

In the present study, no significant age and gender difference was noted with regard to the presence of AMF. This is in accordance with most of the other studies [1,10-13,34-36].

On the contrary; a study reported that AMF occurred predominantly in males when four ethnic groups were considered together, whereas this gender difference was not evident in any of the individual ethnic groups [3]. A polish study also reported that AMF were more commonly seen in males than females [29].

The number of AMF has been found to vary from 1 to 6 in a given location, although usually one AMF is present, and occurrence of multiple AMF are rare [11]. In a Turkish study all the subjects (100%) presented with a single AMF [36]. Three Japanese studies have also reported that most of their subjects (65%, 93.7% and 81.8%) presented with a single AMF [10,12,13]. In the present study, the number of AMF varied from 1 to 5 and 79.63% of subjects presented with a single AMF and is in accordance with literature.

The bilateral occurrence of AMF is rare [5]. In the present study, a significant number of subjects, 85.18% presented with unilateral AMF and only 14.81% presented AMF bilaterally, which is in similarity with other two Japanese, Indian and Bulgarian studies [10,13,28,31,32].

AMF has generally been reported to occur more frequently on the right side of the mandible than on the left. In the present study, most of the unilateral AMFs (65.21%) were present on the right side and 34.78% were present on the left side of the mandible, which was in accordance with literature [10,11,13,37]. On the contrary, two Indian studies and one Turkish study reported that AMFs were predominantly noted on the left side [1,30,32].

In several studies, AMF has been found to be commonly located in the posterioinferior position [1,5,10-13,28,34,35]. However, in the present study, most of the AMFs were located in the anterioinferior position and this is in accordance with a Turkish study in which most of the AMF were present in the anterioinferior position [36]. Further, in a Japanese study, the anteroinferior position was the second most common location of AMFs [10].

The position of AMF was influenced by the branched site and length of the accessory branch [12]. In the present study, the distance between AMF and MF ranged from 0.6 to 12.6 mm with a mean of 3.48 mm and the mean distance of AMF to MF in the horizontal plane (5.08 mm) was greater than the distance in the vertical plane (1.88 mm), which was similarly noted in other studies [11,10,13,36].

The mean surface area of AMFs was 1.05 mm^2 with a SD of 0.28 mm was noted in the present study. Similar findings have been noted in other studies. In a Japanese study, it was found to be 1.7 mm^2 (SD- 1.5 mm^2) [13] and in another Turkish study, the mean surface area of AMF was 1.5 mm^2 (SD-0.8 mm^2) [1].

In the present study, the mean surface area of MF with AMFs was 10.76 mm^2 (SD 5.50) and the mean surface area of MF without MF was 10.79 mm^2 (SD of 5.08). No significant difference was noted between the mean surface area of MF, with and without AMFs. This finding is in accordance with a Japanese study, wherein the mean surface area of MF with AMFs was 4.2 mm^2, and without AMFs was 4.5 mm^2 and no significant difference was found [13].

Very few researchers have examined the contents of AMF. The AMF has been considered to be associated with the mental nerve and is presumed to be the result of branching of the mental nerve prior to its exit from the MF [15,38]. A Japanese study suggested the following possibilities with regard to neurovascularisation of the AMF, either a branch of mental nerve entering/exiting the mandible or a branch of an artery (buccal, submental or facial) entering the mandible through accessory foramina [8]. Another Japanese researcher examined the contents of AMF in three cadavers. In the first cadaver, a nerve was seen emerging from the AMF and it supplied the mucous membrane of the middle area of the lower lip and also communicated with the branches of the inferior labial nerve. In the second cadaver, a nerve emerged from the AMF, it ran for 7.26 mm and then divided into two branches which communicated with the buccal nerve and supplied the gingiva of the molar teeth and mucous membrane and skin of the corner of the mouth. In the third cadaver, a nerve emerged from the AMF and divided into two branches and supplied the skin of the corner of the mouth. It also communicated with a branch of the facial nerve [15].

Conclusion

A considerable number of individuals (27%) in the present study presented with AMF. AMF need consideration during implant insertion and any surgical procedure involving the body of the mandible in the premolar and molar region. Injury to the accessory mental nerve distributed in the perimandibular region can induce temporary sensory disturbance, such as pain and paraesthesia. Moreover, there is a possibility of arterial injury resulting in haemorrhage. Recognition of these foramina would also help in better understanding of the nature of the tumor spread and planning of surgical margins. The detection of AMF using CBCT images might help in better patient compliance in cases of failure to obtain complete analgesia if one appreciates the role of accessory foramina. Further studies using cadavers are needed to identify nerve and/or vascular structures passing through AMF. It is important for a radiologist to possess adequate knowledge on the presence and frequency of these accessory foramina and incorporate them in interpretation reports to alert the surgeon.

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Conflict of Interest

No conflict of interest.

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