Prevalence of accessory mental foramina: A study of 4,000 CBCT scans

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ABSTRACT

Introduction: The presence of accessory mental foramina (AMF) is an important consideration prior to any dental implant and surgical treatment to avoid injury to the neurovascular bundle and subsequent post-operative complications. The aim of this retrospective study was to determine the prevalence of AMF from a substantially large sample of the Australian population.

Materials and Methods: The cone beam computed tomography (CBCT) scans of 4000 patients showing the mandible were examined. All mental foramen (MF) were visualised and no cases were excluded. The number of MF/AMF, sex and age were recorded.

Results: The prevalence of AMF was found to be 6.4% (254 patients) in this study. 12 patients exhibited bilateral AMF, and 11 had three mental foramina on one side. One case had a total of five mental foramina with three on the right and two on the left side. No significant sex preference was discovered.

Conclusion: This is the largest study ever to be conducted to evaluate the prevalence of AMF. With nearly one in 15 individuals found to have AMF, clinicians must be acutely aware of this anatomical variation and treatment plan each case accordingly.

Key words: accessory mental foramina; anatomical variation; cone beam computed tomography; mental foramen

INTRODUCTION

The mental foramen (MF) is commonly a solitary oval-shaped structure located adjacent to the apex of the second premolar on each side of the mandible. It permits the exit of the inferior alveolar nerve as the mental nerve to supply sensory innervation to the lower lip, oral mucosa and gingiva. Anatomical variation of the MF has been reported in the literature, with a particular interest in the presence of additional foramina in the vicinity of the MF. These have predominantly been termed accessory mental foramina (AMF). It is necessary to distinguish between a true AMF (one which branches from the mandibular canal) and a nutrient canal (which supplies nutrients to the mandible and has no communication with the mandibular canal) (Iwanaga et al., 2015; Kalender et al., 2012; Katakami et al., 2008; Naitoh et al., 2009; Torres et al., 2015).

To date, there has been significant interest in the course of the mandibular canal, so as to avoid injury to the critical neurovascular structures within. Consideration of the AMF is highly important during many aspects of clinical dentistry such as local anesthesia and oral surgery, for example implant, periodontal and endodontic surgery, in order to avoid post-operative sensory disturbances or hemorrhage, which may lead to an unfavorable outcome of the planned treatment (Cantekin and Şekerci, 2014; Imada et al., 2014; Iwanaga et al., 2016; Muinelo-Lorenzo et al., 2015; Naitoh et al., 2009; Paraskevas et al., 2015; Torres et al., 2015).

Previous studies have reported on the incidence of AMF which ranged widely from 1.4 – 14.3% (Cantekin and Şekerci, 2014; Haktanır et al., 2010; Imada et al., 2014; Iwanaga et al., 2016; Kalender et al., 2012; Katakami et al., 2008; Khojastepour et al., 2015; Muinelo-Lorenzo et al., 2015; Naitoh et al., 2009; Naitoh et al., 2011; Oliveira-Santos et al., 2011; Paraskevas et al., 2015; Sawyer et al., 1998; Udhaya et al., 2013). However, all of these studies (except one) had sample sizes of less than 400, and the sample populations were restricted to a limited number of ethnic groups. Therefore, the currently reported prevalence is likely a less accurate reflection of the AMF number amongst a wider, more culturally diverse population.

The aim of this study was to determine the prevalence of AMF, using cone beam computed tomography (CBCT) scans, amongst a sizeable sample of the Australian population, to more adequately reflect the increasingly racially diverse nature of most contemporary communities.

MATERIALS AND METHODS

Ethics approval was obtained from the Human Research Ethics Committee of the University of Western Australia for this study. To ensure patient confidentiality, all images were de-identified. Data from the last 4000 consecutive CBCT scans which

included the mandible dating back from December 31, 2017 were interpreted by two experienced, board registered (AHPRA) specialist oral and maxillofacial radiologists.

The i-CAT Flex imaging system (Imaging Sciences International Inc, Hatfield, PA, USA) was used. All the scans were taken at 120kV and 5mA, at 14.7 or 26.9 seconds. The exposure volume and field of views varied depending on the clinical indications, however all scans included the body of the mandible in its entirety. The images were reconstructed and evaluated in a minimum of three planes with the digital imaging and communication in medicine (DICOM) viewer TeraRecon (TeraRecon, Inc).

In accordance with the literature, an AMF is described as any foramen of smaller size in the vicinity of the MF, arising from a branch of the mandibular canal (Iwanaga et al., 2015; Kalender et al., 2012; Katakami et al., 2008; Naitoh et al., 2009; Torres et al., 2015). The presence of the MF and any AMF was evaluated for every case. No exclusion criteria were necessary as all MF were visualized. The sex and the age of the patients with AMF were recorded.

Statistical analysis was carried out using IBM SPSS Version 24 (IBM, New York, NY, USA). Frequency analysis was performed to determine prevalence of one or

more AMF. The chi-square test was carried out to determine potential differences between the presence of AMF and the sex of patients. Statistical significance was set at the 95% level.

RESULTS

The presence of AMF was observed in 254 (6.4%) of the 4000 cases. Amongst these, there were 232 cases (5.8%) with unilateral AMF (110 right, 122 left); 12 cases (0.3%) with bilateral AMF (11 cases with 2 right and 2 left, and 1 case with 3 right and 2 left). Three mental foramina (i.e. 1 MF and 2 AMF) were reported in 11 cases (0.3%; 5 right, 6 left). No absence of MF was observed (Table 1).

The sample with AMF consisted of 124 females and 130 males. No significant sex difference was observed. The mean age of the patients with AMF was 47.0 years (SD: 17.2 years, range: 11-82 years).

DISCUSSION

The MF is a vital anatomical structure frequently encountered during implant placement and oral surgery in the premolar and molar areas of the mandible. Additional smaller foramen arising from a branch of the mandibular canal in this region are termed AMF and are important anatomical variations to consider. Whilst

the absence of MF has been reported in the literature (Matsumoto et al., 2013; Oliveira-Santos et al., 2011), this was not discovered in our sample.

The AMF is thought to develop from branching of the mental nerve prior to the formation of the bony foramen at the twelfth gestation week (Iwanaga et al., 2015; Katakami et al., 2008; Naitoh et al., 2009; Toh et al., 1992). The mental nerve is known to have three branches after exiting the MF, one to the skin of the mental area, others to the skin of the lower lip, mucous membranes and gingiva as far as the second premolar (Iwanaga et al., 2015; Katakami et al., 2008; Toh et al., 1992; Torres et al., 2015). An anatomical dissection study by Toh et al. (1992) found that the different distributions of the accessory mental nerve accounted for the varying positions of the AMF. As such, the point at which the mental nerve branches and the length of this accessory mental nerve will influence the location of the AMF (Kalender et al., 2012). It is also interesting to note that the accessory mental nerves have been found to communicate with branches from the facial and buccal nerves (Naitoh et al., 2009).

Awareness of the anatomical variations of the MF is necessary when planning any surgery in this region. Failure to identify and account for the presence of AMF has been suggested as a reason for post-operative complications such as paralysis or hemorrhage following implant insertion or dentoalveolar surgical procedures in this

region (Cantekin and Şekerci, 2014; Imada et al., 2014; Iwanaga et al., 2016; Muinelo-Lorenzo et al., 2015; Naitoh et al., 2009; Paraskevas et al., 2015). It has also been linked to labio-mandibular paresthesia following endodontic overfilling and surgery (Katakami et al., 2008). Additionally, an AMF can present as a periapical radiolucency on conventional plain film radiology, leading to misdiagnosis, hence it is important to be aware of the possibility of multiple mental foramina (Borghesi et al., 2018; Iwanaga et al., 2016).

Although a number of studies have previously assessed the AMF prevalence, all exhibited similar weaknesses of small sample sizes (63 – 386) and relatively homogenous populations (Cantekin and Şekerci, 2014; Haktanır et al., 2010; Imada et al., 2014; Iwanaga et al., 2016; Kalender et al., 2012; Katakami et al., 2008; Khojastepour et al., 2015; Muinelo-Lorenzo et al., 2015; Naitoh et al., 2009; Naitoh et al., 2011; Oliveira-Santos et al., 2011; Paraskevas et al., 2015; Sawyer et al., 1998; Udhaya et al., 2013). This subset is not large enough to accurately evaluate prevalence. The one exception was a study by Sawyer et al. (1998) in the twentieth century, which had a sample size of 705, with the focus being on the prevalence of AMF between various racial groups in North America. Our current study has the largest sample size to date, revealing an AMF prevalence of 6.4%. This is consistent with the previously reported range, confirming the results by Sawyer et al.

Amongst the selected population with AMF, the presence of a unilateral AMF (Figs. 1 and 2) was the most common anatomical variation with a frequency of 5.8% in the total population. Previous studies reported a range from 2.2 – 12.2% (Katakami et al., 2008; Muinelo-Lorenzo et al., 2015; Naitoh et al., 2009; Naitoh et al., 2011; Oliveira-Santos et al., 2011; Udhaya et al., 2013). No significant difference was discovered on the frequency of occurrence of AMF between sides, as was reported in previous studies (Muinelo-Lorenzo et al., 2015; Sawyer et al., 1998).

In our study, bilateral AMF was found to be less common at 0.3%, compared with a range of 0.5 – 7.9% as reported in the literature (Cantekin and Şekerci, 2014; Haktanır et al., 2010; Imada et al., 2014; Iwanaga et al., 2016; Naitoh et al., 2009; Naitoh et al., 2011; Oliveira-Santos et al., 2011; Paraskevas et al., 2015; Udhaya et al., 2013). Individuals with three mental foramina (i.e. 1 MF and 2 AMF) on any given side (0.3%) were also more uncommon than that reported in the literature (0.4 – 0.96%) (Katakami et al., 2008; Muinelo-Lorenzo et al., 2015; Naitoh et al., 2009; Naitoh et al., 2011; Oliveira-Santos et al., 2011; Udhaya et al., 2013). Of interest amongst our findings was one case with a total of five mental foramina: three MF on the right and two MF on the left. One other such case has been reported in the literature where five mental foramina (three MF on the right and two on the left) were also detected during CBCT examination in a male patient

(Borghesi et al., 2018). The maximum number of MF that has been reported in the literature is six in total, also in a male patient, equally distributed with three on the left and three on the right (Iwanaga et al., 2016).

No significant sex preference for AMF has been found in any of the studies conducted to date (Cantekin and Şekerci, 2014; Khojastepour et al., 2015; Muinelo-Lorenzo et al., 2015; Naitoh et al., 2009; Oliveira-Santos et al., 2011). However, it has been suggested that AMF are more common amongst males in certain racial groups, such as African Americans (Sawyer et al., 1998).

Due to the heterogeneous nature of the Western Australian population, differences between ethnic groups was not assessed in our study. However, a number of previous studies have reported that the presence of AMF was more common among non-Caucasian individuals (Toh et al., 1992), particularly among the Asian, sub-Saharan population (Naitoh et al., 2009), and Polynesian groups (Sawyer et al., 1998).

3D volumetric imaging techniques such as CBCT or multidetector computed tomography (MDCT) should be conducted prior to implant placement and surgical procedures in the mandibular premolar and molar regions to avoid complications (Iwanaga et al., 2016; Muinelo-Lorenzo et al., 2015). In the past, panoramic and

intraoral radiographs have been used to assess the MF and its variations. However, this is not always reliable as AMF are often not visible on plain 2D radiographs due to the geometric projection, inherent distortion and the smaller size of the AMF (Cantekin and Şekerci, 2014; Imada et al., 2014; Katakami et al., 2008; Muinelo-Lorenzo et al., 2015; Naitoh et al., 2011; Toh et al., 1992; Torres et al., 2015). CBCT is a popular method for assessment of the MF and AMF due to the higher osseous spatial resolution and potentially lower radiation dose than MDCT (Aminoshariae et al., 2014; Borghesi et al., 2018; Imada et al., 2014; Iwanaga et al., 2016; Kalender et al., 2012; Torres et al., 2015). It should be noted that MDCT is equally capable of providing a detailed anatomical image for the preoperative planning of treatment in this area (Haktanır et al., 2010). The accuracy of these 3D methods in the detection of AMF only applies with the use of multiplanar reformatted images from the dataset, and not with surface nor volume rendered images which have been reported to be popular amongst general dental practitioners for treatment planning (Iwanaga et al., 2017). It should be clearly emphasized that it is well accepted amongst radiologists (including our observers) that both CBCT and MDCT must be viewed in the orthogonal planes as well as on multiplanar reformatted images such as serial transaxial (cross-sectional) slices. The limitations of volumetric rendered images are recognized and their use in clinical treatment planning is insufficient. In fact, a study by Iwanaga et al. (2017)

concluded that AMF smaller than 1.3mm^2 could not be clearly detected on surface rendered images, which therefore should be used with caution.

With its substantial sample size, this study has confirmed that AMF are not uncommon amongst the general population, with nearly one in 15 individuals exhibiting this anatomical variation. As such, the clinician must be acutely aware of it during the diagnosis and surgical planning stages, with due consideration given to 3D imaging or referral as required, in order to avoid misdiagnosis, patient injury, and prevent complications in the premolar and molar regions of the mandible.

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Table 1 - Distribution of sex of patients with AMF.

Sex	2 R	2 L	2 R 2 L	3 R	3 L	3 R 2 L	Total
Female	59	60	3	2	0	0	124
Male	51	62	8	2	6	1	130
Total	**110**	**122**	**11**	**4**	**6**	**1**	**254**