Int J Pharm Bio Sci 2015 July; 6(3): (B) 1222 - 1228

Review Article **Craniofacial Biology**

International Journal of Pharma and Bio Sciences

ISSN 0975-6299

MENTAL FORAMEN, INFERIOR ALVEOLAR CANAL AND MORPHOLOGY OF MAXILLARY SINUS: A REVIEW

SHAILA ZAMAN[1], MOHAMMAD KHURSHEED ALAM[*1], HAMID H ENEZEI[2&3], REHANA BASRI[4], SHAIFULIZAN ABDUL RAHMAN[2].

1 Orthodontic Unit, School of Dental Science, Universiti Sains Malaysia.
2 Oral and Maxillofacial Surgery, School of Dental Science, Universiti Sains Malaysia
3 College of Dentistry, Anbar University, Iraq.
4 Craniofacial Biology, School of Dental Science, Universiti Sains Malaysia.

ABSTRACT

The aim of this study was to review the different locations of mental foramen, inferior alveolar canal and morphology of maxillary sinus in between different ages in different population. Several electronic databases such as Google Scholar, PubMed, Web of Science and Science Direct were systematically searched for studies published until March 2015. The locations of mental foramen and inferior alveolar canal have many variations. These variations are influenced by races and sometimes gender.

Key words: **Inferior alveolar canal, Inferior alveolar nerve, Mental foramen, Maxillary sinus, Orthopantamograph..**

MOHAMMAD KHURSHEED ALAM
Orthodontic Unit, School of Dental Science, Universiti Sains Malaysia.

***Corresponding author**

INTRODUCTION

Mental foramen (MF) shares its importance in various fields of dentistry. It is defined as, "A funnel like opening on the lateral surface of the mandible at the terminus of the mandibular canal", it transmits mental nerve and vessels providing sensory innervation and blood supply, respectively[1]. It is the front opening of mandibular canal on the body of the mandible and above the tubercle of chin. Mental nerve passes through MF and supplies the chin, lower lip, buccal mucosa of incisors, canines and premolars[2]. "The chambers embedded into the bones around the nasal cavity and opening into the nasal cavity are called paranasal sinuses"[3]. Maxillary Sinus (MS) is the first and largest sinus of the paranasal sinuses which appears at the end of the second embryonic month and they get mature size when the permanent teeth fully developed[4; 5]. The floor of the MS is formed by the alveolar process of maxilla [6;7], and its continuity with the upper posterior teeth remains throughout the life[8;9]. The maxillary sinus is a pyramid-shaped osseous cavity, the base is formed by the nasal antral wall and the tip lying in the zygomatic bone. Its average volume is about 15 cc.[10]. Inferior alveolar canal (IAC) is an important anatomical structure in the mandible, where the inferior alveolar nerve (IAN) passes through. The canal may be positioned at different locations in the mandible[11]. The IAN is the major sensory branch of the posterior trunk of the mandibular nerve[12] and it is carried by IAC[11]. IAN stimulates gingiva, teeth and also supplies mucosa of lower lip and skin of lower lip & chin. In the IAC it runs downwards and forwards, and then horizontally forward, where it divides into the terminal incisive and mental branches[11;12]. The IAN passes anteriorly in the IAC to transverse the mandible from the lingual to the buccal side[12;13]. IAC conduct by using intra oral periapical radiograph, Orthopantomograph (OPG), CT scan, CBCT, MRI[12;13;14]. The aim of this study was to review the different locations of MF, IAC and morphology of MS in between different ages in different races.

MATERIALS AND METHODS

First the strategy was to search the electronic database (Table-1) with various key word combinations (Table-2). The search was directed in four main database and the search for article carried out until March 2015. Additionally, a hand search of oral and maxillofacial surgery and orthodontics textbooks as well as in the reference list.

Table 1
Electronic database search

Google Scholar
PubMed
Science Direct
Web of Science

Table 2
Key Word Combination

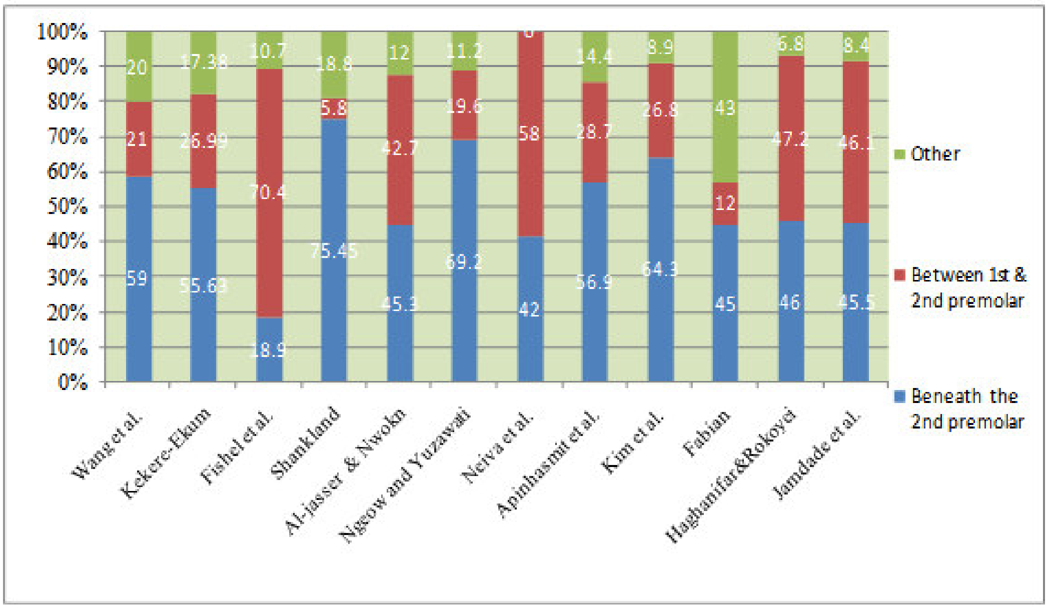
Review + MS
Review + MF
Review + IAC
Morphometry + MS
Morphometry + MF
Morphometry + IAC
OPG + MS
OPG + MF
OPG + IAC

MS- Maxillary Sinus, MF- Mental Foramen, IAC-Inferior Alveolar Canal, OPG- Orthopantamograph.

DISCUSSION

OPG shows greater part of the maxilla facial skeleton as a continuous image which creates more accuracy to detect the location of both MF in both vertical and horizontal dimensions. But a study done by Phillips et al.[15], stated that it is very difficult to compare between right and left foramen in periapical radiograph and it may not reveal the position of the MF if it is below the edge of film[15]. But Parnia et al.[16] in 2012 found that CBCT has magnification free and 3-dimension visualization, where OPG has a large degree of magnification and OPG fails to detect MF where it is not clearly visible[15;16;17]. MRI can detect mandibular nerve better than CBCT but the equipment and imaging are very expensive[18]. According to Mahmoud et al.[19], ultrasound system has no ionizing radiation and real-time identification but still equipments are not readily available. According to the textbooks and previous studies, the common location of MF is either below the apex of the 2nd premolar[15;20;21;22;23;24] or in between the apices of the 1st and 2nd premolar[25;26;27;28]. However, there are anatomical variations of the location of MF[20;29]. Many authors found the foramen is usually located halfway between the crest of the bone and the inferior border of the mandible[30]. Al-Jasser and Nwokn[23] studied on the 414 cases of Saudi population and found 45.3% beneath the apex of 2nd premolar, 42.7% in between the 1st and 2nd premolar. Fishel et al.[31] found 70.4% in between the 1st and 2nd molar on 1000 Caucasian people, Shankland[20] found 75.4% beneath the 2nd premolar on 138 Asian Indian, Kim et al.[36] found 64.3% beneath the 2nd molar and 26.8% in between the two premolars. So it may be concluded that common location of MF is between 1st and 2nd premolar and beneath the 2nd premolar. However, the location is not constant. There were no differences seen between males and females in the position of MF.

Figure 1
Location of MF in different races.[20;21;23;31-39]



The development pattern of the MS may differ according to age and sex. In different studies MS volumes and dimensions show a wide range. Jasim et al.[40] found that the MS volume in right and left side of male were (23.98 ± 0.81), (23.9 ± 0.83) cm3; (24.07 ± 0.62), (24.67 ± 0.63) mm; (36.12 ± 0.62), (39.2 ± 0.61) mm; (39.68 ± 0.61), (39.50 ± 0.63) mm and for females (22.96 ± 0.44), (23.02 ± 0.46) cm3; (22.38 ± 0.95), (22.26 ± 0.94) mm; (35.0 ± 0.9), 35.14 ± 0.82)mm; (36.55 ± 1.26), (36.67 ± 1.06) mm respectively and the mean value of maxillary sinus volume, width, height of males (23.94 ± 0.82) cm3, (24.37 ± 0.62) mm; (36.16 ± 0.61)mm , (39.59 ± 0.62) mm and of females (22.99 ± 0.45) cm3, (22.32 ±

0.94) mm, (35.07 ± 0.86)mm, (36.61 ± 1.16) mm, respectively. So there was no significant difference between right and left side of maxillary sinus but significant changes in between male and female were noticed. Male MS were larger in volume, wider, higher and deeper than females. Teke et al.[41] studied Turkish population and found the MS in males were larger in volume and wider than that of females, as well as deeper and higher in males than in females. And there was no significant change in right and left side. Park et al.[42], Amusa et al.[43] findings were also similar with the Jasim et al.[40] and Teke et al.[41] studies. Whereas Purmal et al.[44] found a difference in height between left and right for the first time. Cases involving nasal sinuses can be accurately diagnosed and treated by using complex imaging techniques [45].

Table 3
Morphology of MS in different races.

Author	Population	Type	Male	Female
Park et al.[42] 2000	Korean	MV	23.76 ± 8.29 cm3	18.98 ± 4.77 cm3
		MW	29.67 ± 6.18 mm	27.18 ± 4.35 mm
		MD	40.67 ± 4.53 mm	38.86 ± 3.23 mm
		MH	47.88 ± 5.98 mm	45.50 ± 4.47 mm
Teke et al.[41] 2007	Turkish	***Width***		
		Right	27.19 ± 5.46 mm	24.44 ±3.61 mm
		Left	26.89 ± 5.52 mm	24.27 ± 3.98 mm
		Depth		
		Right	42.58 ± 7.9 mm	37.8 ± 5.69 mm
		Left	43.7 ± 7.78 mm	37.6 ± 6 mm
		Height		
		Right	47.6 ± 6.4 mm	45.1 ± 4.6 mm
		Left	47.2 ± 6.5 mm	43.6 ± 4.4 mm
Amusa et al.[43] 2011	Nigerian	MV	11.59 ± 5.36 cm3	14.98 ± 10.77 cm3
Jasim et al.[40] 2013	Iraq	***Volume***		
		Right	23.98 ± 0.81 cm3	22.96 ± 0.44 cm3
		Left	23.9 ± 0.83 cm3	23.02 ± 0.46 cm3
		Width		
		Right	24.07 ± 0.62 mm	22.38 ± 0.95 mm
		Left	24.67 ± 0.63 mm	22.26 ± 0.94 mm
		Depth		
		Right	36.12 ± 0.62 mm	35.0 ± 0.9 mm
		Left	39.2 ± 0.61 mm	35.14 ± 0.82 mm
		Height		
		Right	39.68 ± 0.61 mm	35.0 ± 0.9 mm
		Left	39.50 ± 0.63 mm	35.14 ± 0.82 mm

MV- Mean Volume, MW- Mean Width, MD- Mean Depth, MH- Mean Height

The IAC has great importance to the oral and maxilofacial surgery . In panaromic radiograph location of IAC can determine easily but sometimes there is an overlapping between tooth and canal in that case the CBCT is preferable[49]. Studies had been done for the accruate location of the IAC with different radiographic methods. Researchers used five variables, and they are[11;12].

- **D1-**The distance from superior border of the IAC to apical end of the mandibular 2nd molar.
- **D2-**The distance from superior border of the IAC to apical end of the second premolar.
- **D3-** The distance from superior border of the IAC to alveolar crest in between the 1st and 2nd molar.
- **D4-** The height of the alveolar canal.
- **D5-** The distance from the inferior border of the IAC to the inferior border of the mandible.

Goswami et al.[12], studied OPG of 160 Indian population (80 male & 80 female), aged between 20-60 years. The study based on D1, D2, D3, D4, D5 classification and the OPG was analysed by the Sirona software. The study showed no significance between right and left side measurement (p>0.05= not significant). Relationship between age and parameter in male and female showed a significant relation with all except D3. When age increases the D1, D2, D4, D5 varies but only D3 decreases. Ayad et al.[11] studied on Sudanese population, agreed with the studies of Goswami RD et al.[12] except D2 and D3. These studies were also similar to other population studies done by Denio et al.[46] and Levine et al.[14] for all values except D4. These studies also agree with Ikeda et al.[47] for D4 values. But these studies were not in congruence with the study done by Sato et al.[48] for D4 values.

CONCLUSION

From this review it can be concluded that there were no significant differences between males and females of MF, the location of MF in between the 1st and 2nd premolar and beneath the 2nd premolar was most commonly documented. We were not able to find any significant difference between the right and left side of MS. All studies were in agreement with MS in males being larger in volume, width, depth and height than MS of females. The difference between right and left side of IAC were inconclusive and D1, D2, D3, D4, D5 as variables were correlated well with the age in both genders. Variations in measurement occurred in D3 values as age increased.

ACKNOWLEDGEMENT

USM short term grant (304/PPSG/61313103).

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