Original Article

Determination of Chronologic Age by Cone-Beam Computed Tomography Analysis of the Mental Foramen in the South Indian Population

TS Subhash, Sowmya Halasbalu Kallgari[1], HM Hema[2], Y Manohara A Bhat

From the Department of Dentistry, Mysore Medical College and Research Institute, [1]Department of Conservative and Endodontic, JSS Dental College and Hospital, Mysore, [2]Department of Oral Medicine and Radiology, Dentascan CBCT Centre, Bengaluru, Karnataka, India

Received: 07 September, 2019.
Revised: 24 October, 2019.
Accepted: 26 November, 2019.
Published: 26 December, 2019.

ABSTRACT

Background: Chronological age determination is one of the most challenging tasks for forensic experts and anthropologists using living humans or skeletal remaining.

Aim: The aim of this study is to determine the chronological age by cone-beam computed tomography (CBCT) (three-dimensional) analysis of the mental foramen among the South Indian population.

Methodology: A total of 115 individuals' CBCT images were used for analysis. Space from the superior border of the mental foramen to the lower border of the mandible (SLM) and the inferior border of the mental foramen to the lower border of the mandible (ILM) was analyzed by three examiners and recorded.

Statistical Analysis: Descriptive statistics, ANOVA test, and Tukey's *post hoc* analysis were utilized for statistical comparisons.

Results: The mean age of included 115 (male: 66 and female: 49) participants was 40.96 ± 0.5. The mean distance of SLM and ILM among 18–20, 21–30, 31–40, 41–50, 51–60, and 61–70 years' age group participants exhibited statistically significance in the right (P = 0.01 and 0.016) and left (P = 0.001 and 0.001) sides, respectively.

Conclusion: Distance from the mental foramen to the lower border of the mandible remains constant throughout the lifetime, and the measurement is not significant clinically even though it displays statistical significance.

Keywords: *Cone-beam computed tomography, chronologic age, mental foramen*

Introduction

Determination and identification of sex and age from human skeletal remaining specifically in mass disasters, totally mutilated and decomposed remains, is a challenging task for forensic dentists and anthropologists.

Forensic experts rely on certain skeletal remains which can direct toward accurate identification of age and sex. Moreover, also in age-specific policy implementation and legal judgments, the estimation of specific age is mandatory. One of such age-specific skeletal evidence is human mandible. It is the strongest bone, which can available in a well-preserved state longer than any other human bone.[1] Therefore, physical and morphological features of the human mandible are commonly used by forensic experts to determine chronological age.[2] The mental foramen is one of the most stable and specific anatomical landmarks on the mandible.[3,4]

Various researches indicated radiographs of the mental foramen as an essential instrument in forensic anthropology and till date have very comprehensively depended on its effectiveness. Even though it gives an approximate age range, it shares some of the limitations and inaccuracies. It delivers a two-dimensional (2D) image which fails to record important measurements leading to lots of presumption with succeeding loss of numerous data that are vital for near-accurate estimates in forensic sciences.[3-8]

Currently, with scientific encroachment and technological progress, it is possible to produce accurate anatomical landmarks in 3D platforms which can be well documented, preserved, reviewed, and shared with other anthropologists. One such technological advancement is in the form of cone-beam computed tomography (CBCT).[9,10]

Skeletal characteristics show its variation among different ethnic races. Hence, a systematic compilation of population-specific standards is needed.[4,5,11] There are meager data available on the same among the South Indian population. Hence, in the present research, we intended to determine the

Address for correspondence:
Dr. Y Manohara A Bhat, E-mail: manoharpangala@gmail.com

How to cite this article: Subhash TS, Kallgari SH, Hema HM, A Bhat YM. Determination of chronologic age by cone-beam computed tomography analysis of the mental foramen in the South Indian population. Int J Forensic Odontol 2019;4:82-6.

Access this article online

Quick Response Code:

Website: www.ijofo.org

DOI: 10.4103/ijfo.ijfo_15_19

chronological age from the analysis of the mental foramen on CBCT (3D) in the South Indian population.

Methodology

A retrospective study conducted with the data of 115 South Indian people of both sexes using CBCT (Kodak 9500 Series) was commenced in the Department of Forensic Odontology, JSS Dental College, Mysore, and at Dentascan CBCT Centre, Bengaluru, from micron resolution. The attuned scan parameters were 90 Kvp and 10–42 mA depending on the mass of the patients. The exposure time was set at 12 s [Figure 1].

All the three examiners were blinded so that to diminish the inter-examiner bias that could result from selection, reforming or identifying anatomical specific site landmarking undertaken on the CBCT slices. The inclusion criteria comprised the individuals >18 years whose skeletal development had been accomplished and only high-quality images with the correct position and recognizable structures were selected with a known patient's age, sex, and origin. (The first generation of parentage was considered.) The rejection criteria were the individuals with pathologic lesions in the mandible.

A total of 150 CBCT images were examined, of which only 115 were nominated for the study which fulfilled the inclusion criteria (66 males and 49 females). Multiplanar reformatted images were shaped from the data set, and the transverse section was used for identification. Following documentation of foramina, three transverse sections were obtained of each right and left side; now, the best slice among the three sections was recognized in agreement with three observers [Figures 2-4], and a tangent was drawn from the superior and inferior borders of the mental foramen, respectively, using the ruler software (Cs = 3D). Now, perpendiculars were drawn from these two tangents to the bottommost of the mandible (maximum parabolic curvature), and distances were noted both on the right and left sides simultaneously [Figure 5].

The data so acquired were recorded, organized, and subjected to statistical analysis with the Statistical Package for the Social Sciences (SPSS) (version 20, SPSS Inc., Chicago, IL, USA).

Results

From selected 115 CBCT images, 66 and 49 imaginings represent to men and women, respectively. The average age of the patients was 36.49 ± 13.91 [Table 1]. The mental foramen was existing in both the sides of all the imaginings, and the average diameter of the mental foramen was 3.01 ± 1.0 on the left side and 3.4 ± 1.07 on the right side.

The mean distance from the superior border of the mental foramen to the inferior border of the mandible (SLM) on the right side for the age group of 18–20 years was 15.97 ± 0.86 and 15.85 ± 1.41 on the left side; for the age group of 20–30 years, it was 16.88 ± 1.78 on the right side and 16.10 ± 1.77 on the left side; and for the age group of 30–40 years, it was found to be 15.85 ± 1.62 and 15.38 ± 1.59 on the right and left sides, respectively. For the age group of 40–50 years, it was 16.24 ± 1.49 on the right side and

Figure 1: Kodak 9500 – Cone-beam computed tomography

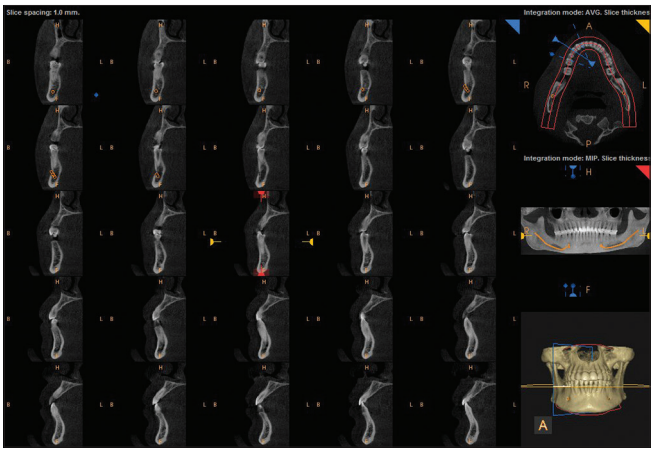

Figure 2: Identification and location of the mental foramen (multiple slices)

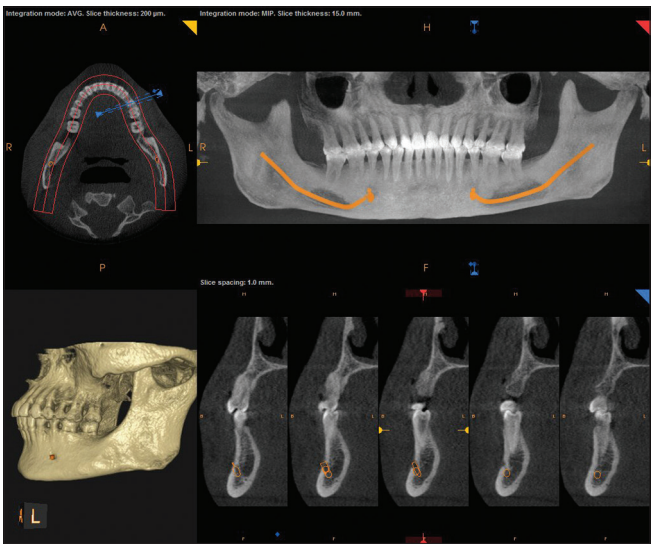

Figure 3: Identification and location of the superior and inferior aspects of the mental foramen

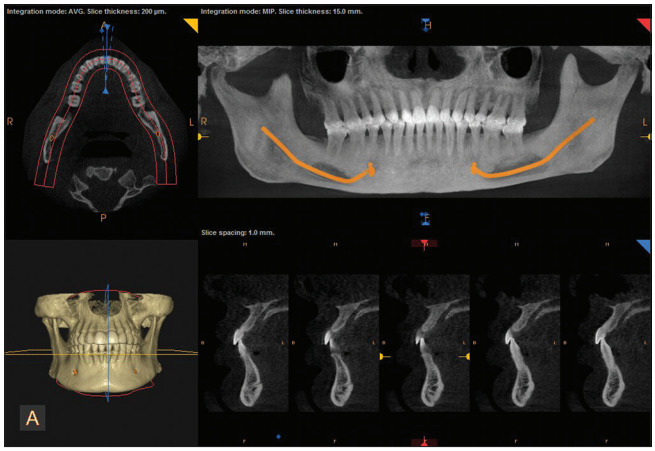

Figure 4: Reformatted three-dimensional image showing the left and right mental foramina

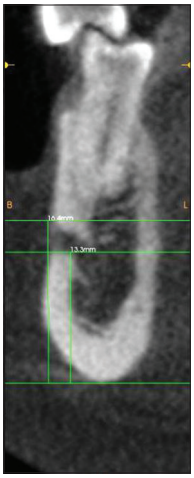

Figure 5: Tangent markings from the upper and lower borders of the mental foramen to the lower border of the mandible

Table 1: Mean age and sex distribution

	n		Mean±SD
	Male	Female	
18-20	6	4	19.4±0.27
21-30	28	14	25.8±0.47
31-40	13	13	34.9±0.54
41-50	8	8	45.1±0.81
51-60	5	5	57.3±0.60
61-70	6	5	63.3±0.33

n: Sample, SD: Standard deviation

16.25 ± 1.583 on the left side; for the age groups of 50–60 and 60–70 years, it was 15.51 ± 2.24 and 14.77 ± 2.46, respectively, on the right side and 14.75 ± 2.14 and 14.33 ± 1.86, respectively, on the left side [Tables 2 and 3].

The mean difference between the age groups on SLM was found to be statistically (one-way ANOVA) significant on both the right (P = 0.01) and left sides (P = 0.016) [Tables 2 and 3]. Tukey's *post hoc* analysis shows that there is a statistically significant difference observed between 21–30 and 61–70 years' age groups (P = 0.008) and found no significance between the rest of the age groups in the right side of the measurements, whereas in the left side, it revealed statistical significance between 21–30 and 61–70 years' age groups (P = 0.036) [Tables 4 and 5].

Similarly, the mean distance from the inferior border of the mental foramen to the lower border of the mandible (ILM) on the right side for the age groups of 18–20, 21–30, 31–40, 41–50, 51–60, and 61–70 years was 13.15 ± 1.33, 13.43 ± 1.83, 12.43 ± 1.23, 12.84 ± 1.70, 11.90 ± 1.43, and 11.22 ± 1.54, respectively, and on the left side of the same age group was 13.42 ± 1.55, 13.13 ± 1.62, 12.39 ± 1.25, 12.89 ± 1.42, 11.44 ± 1.33, and 11.30 ± 1.76, respectively.

The mean difference between the age groups on ILM was found to be statistically (one-way ANOVA) significant on both the right (P = 0.001) and left sides (P = 0.0001) [Tables 2 and 3]. Tukey's *post hoc* analysis displays that there is a statistically significant difference witnessed between 21–30 and 61–70 years' age groups (P = 0.001) in the right side of the measurements, whereas in the left side, 18–20 age group exhibited statistically significant difference with 51–60 age groups (P = 0.04) and 61–70 age group (P = 0.02). Similarly, the age group of 21–30 years displayed a statistically significant difference with 51 - 60 age groups (P = 0.02) and between 61- 70 age groups (P = 0.006) [Tables 4 and 5].

Discussion

In the head region, the mandible is the sturdiest horseshoe-shaped bone.[1,4] The mandible begins its development at the 3rd month of intrauterine life as a small horseshoe bend and inclines to grow up to circumpubertal growth (girls: 11–12 years and boys: 16–18 years). These variations can occur up to the third decade of lifespan because these fluctuations are the result of aging or maturational process rather than growth, and some modifications indicate a decrease rather than increase in magnitudes and are more distinct in females because they initiate and complete their active growth and development period prior than men, also initiate aging former, and exhibit more significant variations in the third decade of life.[12]

The mental foramen is a significant landmark positioned on each side of the buccal cortex of the mandible near the apices of the bicuspids. The positioning of the mental foramen among different ethnic groups has shown to be situated accurately at the same level.[13]

Most of the researches to identify the morphology and location of the mental foramen are based on the panoramic radiographic images (2D). It is a curved plane tomographic radiographic procedure used to define the body of the mandible, the maxilla, and the lower half of the maxillary sinuses on a single view. The capacity to assess the whole body of the mandible allows the precise position of the mental foramen in both horizontal and vertical dimensions on panoramic radiographs.[14] However, it fails to produce in the transverse dimension. Hence, it slips some of the major

Table 2: Mean difference between three age groups among right SLM and right ILM

Side	Position	Age group	*n*	Mean±SD	SE	95% CI for mean		*F*	*P*
						Lower bound	Upper bound		
Right	Right SLM	18-20	10	15.97±0.86	0.27	15.35	16.59	3.21	0.01*
		21-30	42	16.88±1.78	0.27	16.33	17.44		
		31-40	26	15.85±1.62	0.32	15.19	16.51		
		41-50	16	16.24±1.49	0.37	15.44	17.03		
		51-60	10	15.51±2.24	0.71	13.91	17.11		
		61-70	11	14.77±2.46	0.74	13.12	16.43		
	Right ILM	18-20	10	13.15±1.33	0.42	12.20	14.10	4.46	0.001*
		21-30	42	13.43±1.83	0.28	12.86	14.00		
		31-40	26	12.43±1.23	0.24	11.94	12.93		
		41-50	16	12.84±1.70	0.43	11.93	13.75		
		51-60	10	11.90±1.43	0.45	10.88	12.92		
		61-70	11	11.22±1.54	0.46	10.18	12.25		

*Statistical significance at >0.05. SLM: Distance from the superior border of the mental foramen to the lower border of the mandible, ILM: Distance from the inferior border of the mental foramen to the lower border of the mandible, *n*: Sample, SD: Standard deviation, SE: Standard error, CI: Confidence interval

Table 3: Mean difference between three age groups among left SLM and left ILM

Side	Position	Age group	*n*	Mean±SD	SE	95% CI for mean		*F*	*P*
						Lower bound	Upper bound		
Left	Left SLM	18-20	10	15.85±1.40732	0.44503	14.8433	16.8567	2.93	0.016*
		21-30	42	16.1024±1.77688	0.27418	15.5487	16.6561		
		31-40	26	15.3808±1.59022	0.31187	14.7385	16.0231		
		41-50	16	16.25±1.58367	0.39592	15.4061	17.0939		
		51-60	10	14.75±2.14644	0.67877	13.2145	16.2855		
		61-70	11	14.3364±1.8624	0.56154	13.0852	15.5875		
	Left ILM	18-20	10	13.42±1.55048	0.49031	12.3109	14.5291	4.68	0.001*
		21-30	42	13.1357±1.62102	0.25013	12.6306	13.6409		
		31-40	26	12.3923±1.25441	0.24601	11.8856	12.899		
		41-50	16	12.8938±1.42196	0.35549	12.136	13.6515		
		51-60	10	11.44±1.336	0.42248	10.4843	12.3957		
		61-70	11	11.3091±1.76378	0.5318	10.1242	12.494		

*Statistical significance at >0.05. SLM: Distance from the superior border of the mental foramen to the lower border of the mandible, ILM: Distance from the inferior border of the mental foramen to the lower border of the mandible, *n*: Sample, SD: Standard deviation, SE: Standard error, CI: Confidence interval

information. The radiographic mental foramina may represent a section of the mental canal and not the foramen itself.[4,8,15] However, with advances in digitalization and introduction of 3D imaging like CBCT, where we can obtain the transverse section of up to 3 mm, we have decided to practice this advancement to avoid the drawbacks of panoramic radiographs.[9,10]

Based on the proven literature,[14,16,17] the distance from the foramen to the inferior border of the mandible (basal bone) remains relatively constant and therefore can be accounted or considered as a stable landmark on the mandible. Hence, the distance from the superior and inferior borders of the mental foramen to the lowermost borders (maximum parabolic curvature) of the mandible on both sides was used in the present research.

The result of the present research indicates that there is a significant difference observed between the age groups but failed to show a difference within groups. There is a significant difference between 21–30 and 50–60 years' age groups and also between 21–30 and 60–70 years' age groups. This significant difference is due to less bone resorption and craniofacial changes in the mandible.[12,17] This makes that mandibular bone changes are less sensitive to age changes. Although the present research gives statistically significant changes, it failed to reproduce the same in a clinical scenario. Further researches are needed in this direction to provide more concrete information.

Conclusion

The present research confirms that distance from the mental foramen to the lower border of the mandible is stable throughout life and shows minimal changes. Even though the results demonstrate the statistical significance but failed to establish clinical significance.

Table 4: Mean difference within the age groups (Tukey's *post hoc*) among right distance from the superior border of the mental foramen to the lower border of the mandible and distance from the inferior border of the mental foramen to the lower border of the mandible

	Age group					
	18-20	21-30	31-40	41-50	51-60	61-70
Right SLM						
18-20	0	−0.91	0.12	−0.27	0.46	1.20
21-30		0	1.03	0.65	1.37	2.11* (0.008)
31-40			0	−0.39	0.34	1.08
41-50				0	0.73	1.46
51-60					0	0.74
61-70						0
Right ILM						
18-20	0	−0.28	0.72	0.31	1.25	1.93
21-30		0	0.99	0.59	1.53	2.20* (0.001)
31-40			0	−0.40	0.53	1.22
41-50				0	0.94	1.62
51-60					0	0.68
61-70						0

*Statistical significance at >0.05. SLM: Distance from the superior border of the mental foramen to the lower border of the mandible, ILM: Distance from the inferior border of the mental foramen to the lower border of the mandible

Table 5: Mean difference within the age groups (Tukey's *post hoc*) among left distance from the superior border of the mental foramen to the lower border of the mandible and distance from the inferior border of the mental foramen to the lower border of the mandible

	Age group					
	18-20	21-30	31-40	41-50	51-60	61-70
Left SLM						
18-20	0	−0.25	0.47	−0.40	1.10	1.51
21-30		0.00	0.72	−0.15	1.35	1.76* (0.036)
31-40			0.00	−0.87	0.63	1.04
41-50				0.00	1.50	1.91
51-60					0.00	0.41
61-70						0.00
Left ILM						
18-20	0	0.28	1.03	0.53	1.98* (0.04)	2.11* (0.02)
21-30		0.00	0.74	0.24	1.69* (0.02)	1.82* (0.006)
31-40			0.00	−0.50	0.95	1.08
41-50				0.00	1.45	1.58
51-60					0.00	0.13
61-70						0

*Statistical significance at >0.05. SLM: Distance from the superior border of the mental foramen to the lower border of the mandible, ILM: Distance from the inferior border of the mental foramen to the lower border of the mandible

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Hu KS, Koh KS, Han SH, Shin KJ, Kim HJ. Sex determination using nonmetric characteristics of the mandible in Koreans. J Forensic Sci 2006;51:1376-82.
2. Sweet D. Why a dentist for identification? Dent Clin North Am 2001;45:237-51.
3. Mahima V, Patil K, Srikanth H. Mental foramen for gender determination: A panoramic radiographic study. Med Leg Update 2009;9:33-5.
4. Subash T, Balaraj B, Hema C. Determination of sex by cone-beam computed tomography analysis of mental foramen in South Indian population. Int J Forensic Odontol 2019;4:21.
5. Chandra A, Singh A, Badni M, Jaiswal R, Agnihotri A. Determination of sex by radiographic analysis of mental foramen in North Indian population. J Forensic Dent Sci 2013;5:52-5.
6. Phillips JL, Weller RN, Kulild JC. The mental foramen: 3. Size and position on panoramic radiographs. J Endod 1992;18:383-6.
7. Yosue T, Brooks SL. The appearance of mental foramina on panoramic radiographs. I. Evaluation of patients. Oral Surg Oral Med Oral Pathol 1989;68:360-4.
8. Yosue T, Brooks SL. The appearance of mental foramina on panoramic and periapical radiographs. II. Experimental evaluation. Oral Surg Oral Med Oral Pathol 1989;68:488-92.
9. Miles DA. Atlas of Cone Beam Imaging for Dental Applications. USA: Quintessence Pub; 2013.
10. Zöller JE, Neugebauer J. Cone-beam Volumetric Imaging in Dental, Oral and Maxillofacial Medicine: Fundamentals, Diagnostics, and Treatment Planning. USA: Quintessence; 2008.
11. Steyn M, Işcan MY. Sexual dimorphism in the crania and mandibles of South African whites. Forensic Sci Int 1998;98:9-16.
12. Akgül AA, Toygar TU. Natural craniofacial changes in the third decade of life: A longitudinal study. Am J Orthod Dentofacial Orthop 2002;122:512-22.
13. Haghanifar S, Rokouei M. Radiographic evaluation of the mental foramen in a selected Iranian population. Indian J Dent Res 2009;20:150-2.
14. Güler AU, Sumer M, Sumer P, Biçer I. The evaluation of vertical heights of maxillary and mandibular bones and the location of anatomic landmarks in panoramic radiographs of edentulous patients for implant dentistry. J Oral Rehabil 2005;32:741-6.
15. Agthong S, Huanmanop T, Chentanez V. Anatomical variations of the supraorbital, infraorbital, and mental foramina related to gender and side. J Oral Maxillofac Surg 2005;63:800-4.
16. Wical KE, Swoope CC. Studies of residual ridge resorption. I. Use of panoramic radiographs for evaluation and classification of mandibular resorption. J Prosthet Dent 1974;32:7-12.
17. Lindh C, Petersson A, Klinge B. Measurements of distances related to the mandibular canal in radiographs. Clin Oral Implants Res 1995;6:96-103.