Original Research Article
Journal of Forensic Dental Sciences, *Vol 13(2), DOI: 10.18311/jfds/13/2/2021.21, May-August 2021, p. 63-69*
ISSN (Print) : 0975-1475
ISSN (Online) : 0975-2137

Morphometric Analysis of Mandible for Gender determination in adult patients: A Cone Beam Computed Tomography Study

Sandeep Kumar Bains[1*] and Archana Bhatia[2]

[1]Professor and Head, Department of Oral Medicine and Radiology, Surendera Dental College and Research Institute, Sriganganagar - 335001, Rajasthan, India; drsandeepk@yahoo.com
[2]Professor, Department of Periodontics, Surendera Dental College and Research Institute, Sriganganagar - 335001, Rajasthan, India

Abstract

Context: Gender determination is an important component of personal identification. **Aims:** Assessment of gender using mandible with Cone Beam Computed Tomography (CBCT). **Settings and Design:** This cross-sectional prospective study was conducted on dental outpatients in the department of Oral Medicine and Radiology. **Methods and Material:** 148 dental outpatients were selected and subjected to CBCT. Mandibular landmarks such as gonial angle, alveolar ridge to mental foramen distance, mental foramen to the inferior border of mandible distance, mandibular canal to the most anterior tangent point of buccal and lingual mandibular plate distance, mandibular canal border to the lowest tangent point on the inferior border of the mandible, coronoid height, bigonial breadth, minimal ramus breadth and ramus length were assessed on CBCT scan. **Statistical Analysis Used:** Data was represented as mean and Standard Deviation (SD). Parameters were compared between males and females using Kruskal-Wallis and Student's independent T-test. A value below 0.05 represented significant results. **Results:** All parameters except gonial were significantly higher in males as compared to females angle (P< 0.05). The distance from the lowest point of the mandibular canal to the most posterior tangent point of the Mandibular Lingual Plate (MCLM) and bigonial breadth was higher in males than females but the difference was non-significant (P>0.05). The accuracy of CBCT was found to be 89.7% in males and 88.5% in females. **Conclusions:** Gender determination by morphometric analysis of the mandible using cone beam computed tomography is an effective method and provides higher accuracy as compared to two-dimensional conventional radiographs.

Keywords: CBCT, Gonial Angle, Mandible

Key Message: Gender determination is an important part of Forensic Odontology. Gender identification through CBCT is an effective method that provides three-dimensional assessments of parameters.

Introduction

Human identification in forensics is possible through its unique characteristics which vary from person to person and no two individuals share identical features[1]. Gender determination is an important part of the medicolegal practice[2]. Teeth and bones are routinely used for identification[3]. Skeletal remnants were considered to be useful in gender identification[4]. Mandible is the hardest bone of the body which resists physical injury and putrefaction[5]. Gender recognition is primarily based on the morphological distinctiveness of mandible[6]. Cone Beam Computed Tomography (CBCT) is a 3-dimensional radiographic modality which overcomes the shortcoming of other two-dimensional radiographic aids[7]. The present study aimed to assess gender using mandible with Cone Beam Computed Tomography (CBCT).

Subjects and Methods

This cross-sectional study was performed on 148 subjects of both genders after they agreed to participate in the study with their written consent. The study was commenced after an ethical committee of the institute

*Author for correspondence

approved it. The inclusion criteria were adult subjects, completely dentulous and systemic healthy subjects. Exclusion criteria were partially or completely edentulous, dental or skeletal malocclusion, history of traumatic injury to the face, syndromic subjects, subjects with systemic illness, CBCT images with artefacts and those not providing consent.

Subjects were randomly selected from the outpatient department. All recruited subjects were subjected to CBCT scan taken with Planmica (Pro Max) (Finland) CBCT machine operating at 100 kVP, 5-10 mA, and 18 seconds as per manufacturer recommendations. The field of view selected was 11X 8 cm. Slice thickness was 0.3 mm. The image resolution was 0.1µm.

Images were obtained in the axial plane and with the multiplanar reformation, sagittal and coronal planes were prepared. Newtom New Technology (NNT) software was used for all measurements. The following parameters were recorded as:

1. Gonial angle (Go-ang) which is the angle formed between the inferior border of the mandible to the posterior border of the ramus (Figure 1).
2. Distance from the crest of the alveolar ridge to the mental foramen (ACMF) (Figure 2).
3. Distance from mental foramen to the inferior border of the mandible (MFMB) (Figure 2),
4. Distance from the lowest point of the mandibular canal to the most anterior tangent point of the buccal mandibular plate (MCBM) (Figure 3)
5. Distance from the lowest point of the mandibular canal to the most posterior tangent point of the mandibular lingual plate (MCLM) (Figure 3).
6. Distance from the lowest point on the mandibular canal border to the lowest tangent point on the inferior border of the mandible (MCMB) (Figure 4).
7. Coronoid height (Co- Ht), the distance between the coronion and lower wall of bone (Figure 1).
8. Bigonial breadth (BgBr), the distance between the two gonions (Figure 5).
9. Minimal ramus breadth (M-R-Br), which is the smallest anteroposterior ramus breadth (Figure 1).
10. Ramus length (RL), the distance between condylon to gonion (Figure 1). Two independent oral and maxillofacial radiologists performed all measurements and average values were taken as final.

Results obtained after doing all measurements were entered into MS excel sheet. Data were evaluated using SPSS (version 21.0). Data were represented as mean and standard deviation (S.D). Parameters were compared between males and females using Kruskal-Wallis and Student's independent T-test. A value below 0.05 represented significant results.

Figure 1. Assessment of parameters in mandible.

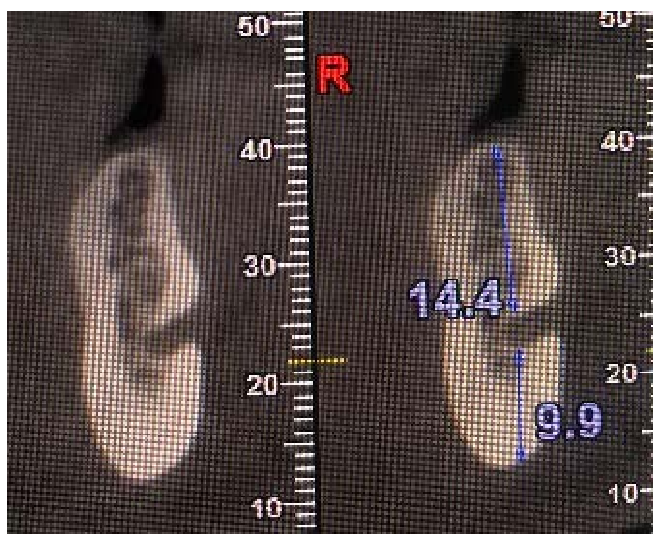


Figure 2. Distance from crest of Alveolar Ridge To Mental Foramen (ACMF) and distance from mental foramen to inferior border of mandible (MFMB).

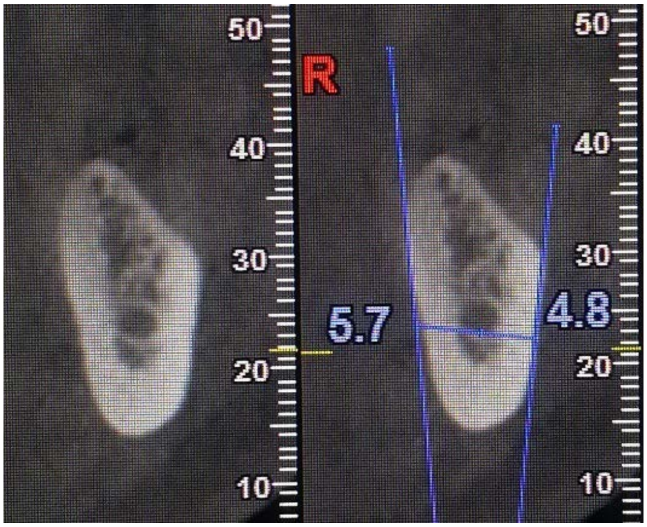


Figure 3. Distance from lowest point of mandibular canal to the most anterior tangent point of buccal mandibular plate (MCBM) and distance from the lowest point of mandibular canal to the most posterior tangent point of mandibular lingual plate (MCLM).

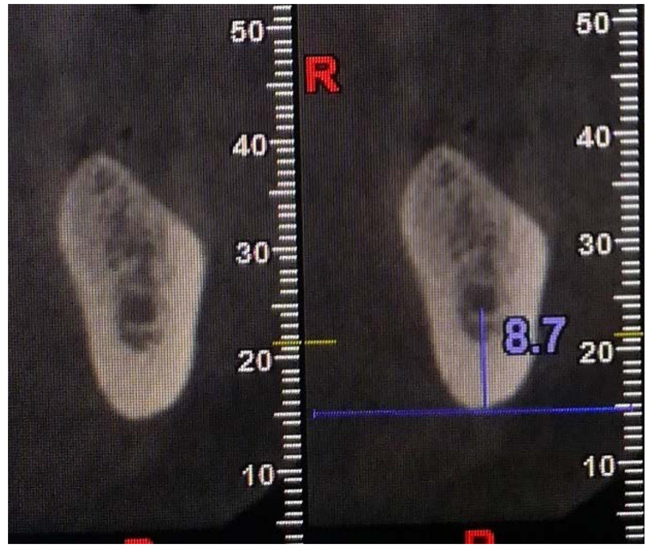


Figure 4. Distance from the lowest point on mandibular canal border to the lowest tangent point on inferior border of mandible (MCMB).

Figure 5. Bigonial Breadth (BgBr).

Results

In the present study there were 78 males and 70 females (Table 1). The mean gonial angle (Go-ang) in males was 112.6±3.4 mm and in females was 122.4±4.2 mm. There was a statistically significant difference between males and females (< 0.05). The mean± SD distance from the crest of the alveolar ridge to mental foramen (ACMF) in males was 14.6±2.5 mm and in females was 13.3±2.1 mm. The difference was significant (P< 0.05). The mean±SD distance from the mental foramen to the inferior border of the mandible (MFMB) in males was 12.9±1.1 mm and in females was 12.1±1.3 mm. A significant difference was found between both genders (< 0.05). The mean±SD distance from the lowest point of the mandibular canal to the most anterior tangent point of the buccal mandibular plate (MCBM) in males was 5.8±1.2 mm and in females was 4.9±0.8 mm. There was a statistically significant difference between males and females (< 0.05). The mean±SD distance from the lowest point of the mandibular canal to the most posterior tangent point of the mandibular lingual plate (MCLM) in males was 4.9±0.8 mm and in females was 4.2±0.6 mm. The difference was non-significant (P>0.05). The mean±SD distance from the lowest point on the mandibular canal border to the lowest tangent point on the inferior border of the mandible (MCMB) in males was 8.8±1.3 mm and in females was 8.0±1.2 mm. A statistically significant difference was obtained between both genders (P< 0.05). The mean± SD coronoid height (Co-Ht) in males was 5.4±1.0 mm and in females was 4.2±1.1 mm. There was a statistically significant difference between males and females (< 0.05).

The mean± SD bigonial breadth (BgBr) in males was 72.9±5.6 mm and in females was 72.6±5.2 mm.

Table 1. Distribution of subjects

Total- 148		
Gender	Males	Females
Number	78	70

Table 2. Assessment of parameters

Parameters	Male	Female	T value	P value
	Mean± SD	Mean± SD		
Go- ang (degree)	112.6±3.4	122.4±4.2	-3.71	0.001
ACMF (mm)	14.6±2.5	13.3±2.1	-3.62	0.002
MFMB (mm)	12.9±1.1	12.1±1.3	4.92	0.01
MCBM (mm)	5.8±1.2	4.9±0.8	4.16	0.001
MCLM (mm)	4.9±0.8	4.2±0.6	2.88	0.08
MCMB (mm)	8.8±1.3	8.0±1.2	3.72	0.05
Co-HT (mm)	51.4±1.0	45.2±1.1	4.36	0.01
BgBr (mm)	72.9±5.6	72.6±5.2	1.17	0.24
M-R-Br (mm)	31.2±1.2	24.6±0.9	3.84	0.05
RL (mm)	62.3±1.8	48.5±1.3	3.71	0.001

Table 3. Assessment of overall predictive accuracy (%)

Gender	Total subjects	Prediction through CBCT	Accuracy	
			True positive (%)	False negative (%)
Male	78	70	89.7	10.3
Female	70	62	88.5	11.5

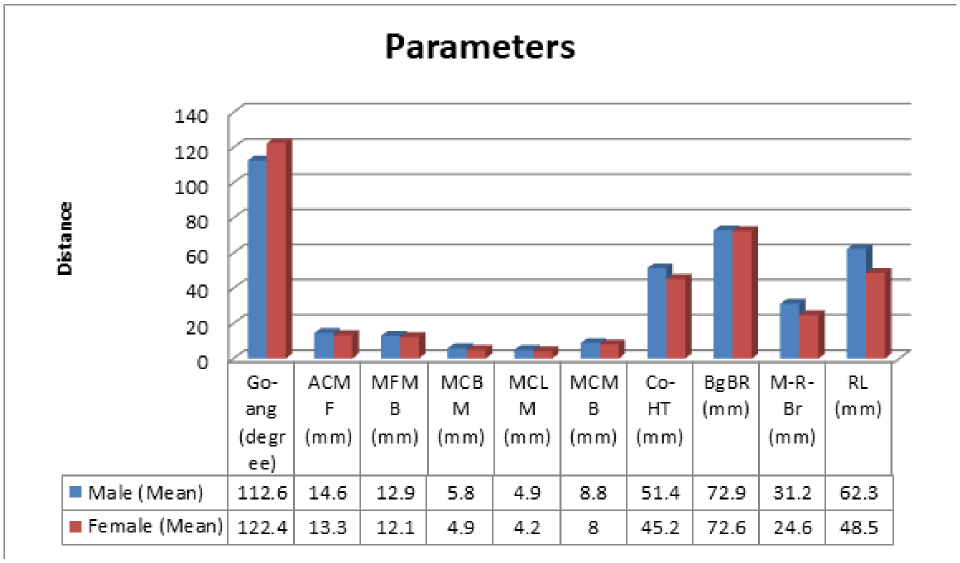
A non-significant difference between both genders was found (P> 0.05). The mean± SD minimal ramus breadth (M- R- Br) in males was 31.2±1.2 mm and in females was 24.6±0.9 mm. The difference was significant (P< 0.05). The mean± SD ramus length (RL) in males was 62.3±1.8 mm and in females was 48.5±1.3 mm. The difference between both genders was significant (P< 0.05) (Table 2, Graph 1).

Table 3 shows that in males, the overall accuracy of CBCT in assessing all parameters was 89.7% and in females was 88.5% whereas false prediction occurred in 10.3% in males and 11.5% in females.

Discussion

Gender identification through bones such as the pelvis and skull is the basics of forensic medicine. Gender determination has become an integral part of the medico-legal practice. Facial bones offer resistance to fire that can last for several days[8]. Mandible is widely used as a diagnostic tool for age and gender determination in forensic dentistry. Skull can reveal 100% accuracy in gender assessment. It is evident that both the pelvis and skull together may determine the gender of an individual with 98% accuracy[9]. In the present study, gender identification through morphometric assessment of the mandible with CBCT was performed.

We found that the mean Gonial Angle (Go-ang) was 112.6±3.4 mm in males and 122.4±4.2 mm in females. Kalllali *et al.*,[10] found that the Gonial Angle was higher in females (120.4^0) as compared to males (114.7^0). Elsalam *et al.*,[11] found that the Gonial Angle was 138.3° in males and 140.9° in females. Tozoglu *et al.*,[12] and Joo *et al.*,[13] also found it bigger in females than males. The reason for greater gonial angle in females may be due to lesser chewing strength than males. It is seen that excessive chewing strength in males leads to lesser gonial angle.



Graph 1. Assessment of parameters.

We found that mean±SD crest of Alveolar Ridge to Mental Foramen (ACMF) distance was 14.6±2.5 mm in males and 13.3±2.1 mm in females. Our results are in agreement with Shams *et al.*,[14] who found that it was 14.4 mm in males and 12.8 mm in females. Uppel *et al.*,[15] also reported higher values in males compared to females.

In this study males (12.9±1.1 mm) had higher mean±SD distance from the mental foramen to the inferior border of the mandible (MFMB) than females (12.1±1.3 mm). We found that the lowest point of the mandibular canal to the most anterior tangent point of buccal mandibular plate (MCBM) distance in males was 5.8±1.2 mm and in females was 4.9±0.8 mm and to the Mandibular Lingual Plate (MCLM) distance in males was 4.9±0.8 mm and in females was 4.2±0.6 mm. However, Shams *et al.*,[14] found MCBM higher in females (4.6 mm) than males (4.3 mm) and MCLM 4.4 mm in females and 4.2 mm in females.

In this study, it was observed that MCMB distance in males was 8.8±1.3 mm and in females was 8.0±1.2 mm. Our results are in agreement with Jayam *et al.*,[16] who also found it higher in males than females. The coronoid height (Co-Ht) in males was 5.4±1.0 mm and in females was 4.2±1.1 mm. Both parameters were found to be relatively higher in males than females. Kharoshah *et al.*,[17] in their study obtained higher coronoid height and mandibular canal border to the lowest tangent point on the inferior border of mandible distance in males in contrast to females.

We observed that bigonial breadth (BgBr) was 72.9±5.6 mm in males and 72.6±5.2 mm in females, however, the difference was not significant. Kallali *et al.*,[10] found 70.9 mm in males and 70.4 mm in females. The mean±SD minimal ramus breadth (M-R-Br) in males was 31.2±1.2 mm and in females was 24.6±0.9 mm. Kalllali *et al.*,[10] found 20.4 mm and 20.2 mm in males and females respectively (P>0.05). The mean Ramus Length (RL) in males was 62.3 mm and in females was 48.5 mm. Elsalam *et al.*,[11] found Ramus Length of 62.4 mm in males and 62.4 mm in females.

It is evident that estrogen and progesterone hormones play an important role in aggravating bone growth and leads to variation in craniofacial morphology between genders. Hormonal changes produce 5-9% bigger craniofacial aspects in males as compared to females. Hence bony parameters are relatively more in males in comparison to females[18]. Masticatory muscles especially the masseter muscle contribute to tension in the mandible which can result in excessive bone growth. Males have stronger masticatory muscles than females leading to bigger bony components.

We found that overall accuracy of CBCT in assessing all parameters was 89.7% in males and 88.5% in females. False prediction occurred in 10.3% of males and 11.5% of females. Kharoshah *et al.*,[17] found an accuracy of 83.9%. Saini et al[19] found 80.2%, and Indira *et al.*,[20] found an accuracy of 86% and 82% in males and females respectively.

Maxillofacial radiography has popularized and is now a routine procedure in many dental, medical hospitals, and private clinics. These radiographs are obtained at regular intervals of time and records are maintained. Gender as well as age can be assessed with dental or skeletal remains if pre-mortem radiographs are available that can be compared easily with post-mortem radiographs[21]. CBCT is a new three-dimensional radiographic aid that offers the advantages of better image quality, and less image distortion as compared to 2-dimensional radiographs such as panoramic radiograph (OPG) and lateral cephalograms. It offers lower radiation dose to patients as compared to CT[22].

The shortcoming of the study is the small sample size. Assessment of age and comparison of sides was not performed.

Conclusion

Gender determination by morphometric analysis of the mandible using cone beam computed tomography is an effective method and provides higher accuracy as compared to 2-dimensional conventional radiographs.

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How to cite this article: Banis S. K. and Bhatia A. Morphometric Analysis of Mandible for Gender determination in adult atients: A Cone Beam Computed Tomography Study. J Forensic Dent Sci. 2021; 13(2):63-69.

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