Role of mandibular anatomical structures in sexual dimorphism in Turkish population: a radiomorphometric CBCT study

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KEYWORDS

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ABSTRACT

Sex determination is one of the primary concerns of forensic science. The cranial bones, pelvis, and mandible have been used for determining the sex of specimens. Because the mandible is robust and sexually dimorphic, studies have evaluated its metric and morphological traits.

This study was designed as a retrospective study involving cone beam computed tomography (CBCT) images to assess sexual dimorphism of the mandible in the Turkish population. Total sample group consisted of 176 bimaxillary CBCT scans (71 males and 102 females; ages 19–67 years). Sixteen mandibular parameters were measured using two different software programmes. Measurements were recorded in various planes of three-dimensional (3D) reconstructions of the scans.

All parameters aside from SIMaCD were found to be statistically significant. The highest diagnostic accuracy rate was associated with IMaF, and the overall accuracy rate of the fourteen parameters was found to be 80%.

INTRODUCTION

Sex determination is one of the main concerns of forensic science. Because of the nature of forensic investigations, not all cases retain full body integrity; therefore, sex assessment should be performed on specific anatomical sites that are predominantly bony structures because of bone's durability postmortem.[1] Earlier studies have revealed that the most reliable bone for sex determination is the pelvis. After the pelvis, the cranium was considered to be the second most reliable bony structure for sex determination.[2]

Previous articles have utilized various methods and parameters to determine the sex of a specimen using the cranium. Traditional methods have been mostly based on visual examination of the morphological properties. This has created a major issue because visual examination is based on subjective evaluation.[3] With recent developments in imaging technologies in medicine and forensic science, radiological imaging methods have become universal. These imaging methods, such as CBCT, which provide non-distorted 3D high spatial resolution radiological data, are favourable for sex prediction, especially 3D modalities presenting accurate morphological information.[4-5] In addition to the above mentioned methods, recent studies have shown that artificial intelligence (AI) techniques can provide reliable data for sex estimation.[6] The superiority of AI over other methods is elimination of investigator bias. However, it should be considered that AI algorithms may also display conflicting results related to human observers.[7] Additionally, to promote this method, forensic scientists must become more familiar with AI. The accessibility limitations of AI algorithms have prevented its widespread use to date.[8]

Thus far, several cranial structures have been found to be scientifically reliable for sex determination. Williams and Rogers conducted a study by visually examining fifty complete or partial adult craniums to determine the sex of the specimens.[9] They evaluated a total of fourteen parameters, including mandibular traits, nasal aperture, and orbital margins, and the overall diagnostic accuracy rate was 96.4%.[9] Uthmann et al. investigated the accuracy rate of the foramen magnum and other cranial measurements for sex identification, revealing 90.7% accuracy for identification of males and 73.3% accuracy for that of females.[10]

The mandible is the most robust bone of the skull and demonstrates sexual dimorphism.[11] Recent articles have recorded forensic and anthropological determinants of sex from mandibular structures.[5,12] Research has been conducted on different ethnic roots and races because skeletal characteristics vary by population.[13,14]

The inferior alveolar canal, which contains the neurovascular bundle, starts with the mandibular foramen at the proximal side of the mandibular ramus and ends with the mental foramen on the anterior side of the mandibular corpus.[15] The position and metrics of the canal differ by population.

The aim of this study was to determine the sex of Turkish dental patients at the Istanbul Medipol University School of Dentistry Dento-Maxillofacial Radiology Department by measuring their mandibular anatomical structures using CBCT images. Our main objective was to establish sex determination through 3D images of the maxillo-mandibular field of view images, which are easily accessible and provide valid parameters that can be measured by dentists, anatomists, and forensic researchers using basic software and CBCT access. Also, by recording linear measurements, the results become more reliable than visual subjective evaluation, which involves no defined parameters.[3]

MATERIAL AND METHODS

This study was designed as a retrospective study involving CBCT images of Turkish dental patients, who presented at Istanbul Medipol University, School of Dentistry, Dento-Maxillofacial Radiology Department. Ethics approval was obtained from Istanbul Medipol University, non-interventional Ethics Committee Number 10840098-772.02-E.60602. The sample group comprised a total of 176 bimaxillary CBCT scans (71 males and 105 females, aged 19–67 years), which were previously taken for various conditions involving impacted teeth, supernumerary teeth, orthodontic consultation, implant surgery planning, pre-orthognathic evaluation, and other possible pathology of the maxilla and mandible. Inclusion criteria were the presence of bilateral mandibular first molars with no periodontal defect. Patients with periodontal disease, acute trauma, Stafne's bone defect, cleft lip and/or palate, or cysts at the relevant sites were excluded.

CBCT scans were obtained using an i-CAT Next Generation (Imaging Sciences, Hatfield, USA) 3D volume scanner at 120 kVp and 20.27 mA for 14.7 seconds. The field of view (FOV) selection included bimaxillary views at 16 cm × 23 cm, and slice thickness was structured at 0.25 mm intervals and isotropic voxels. To measure the parameters, coronal and axial sectioned images were selected. In addition to 2D parameters, measurements were performed on 3D reconstructions of the scans.

Evaluation of the images

Evaluation of the images was performed by two observers who had been trained by a dento-maxillofacial radiology specialist who had 21 years of experience in the field, using Anatomage Vivo Dental software version 5.2 (Anatomage, Inc. California, USA) and i-CAT Next Generation Vision software (Imaging Sciences International, Hatfield, USA).

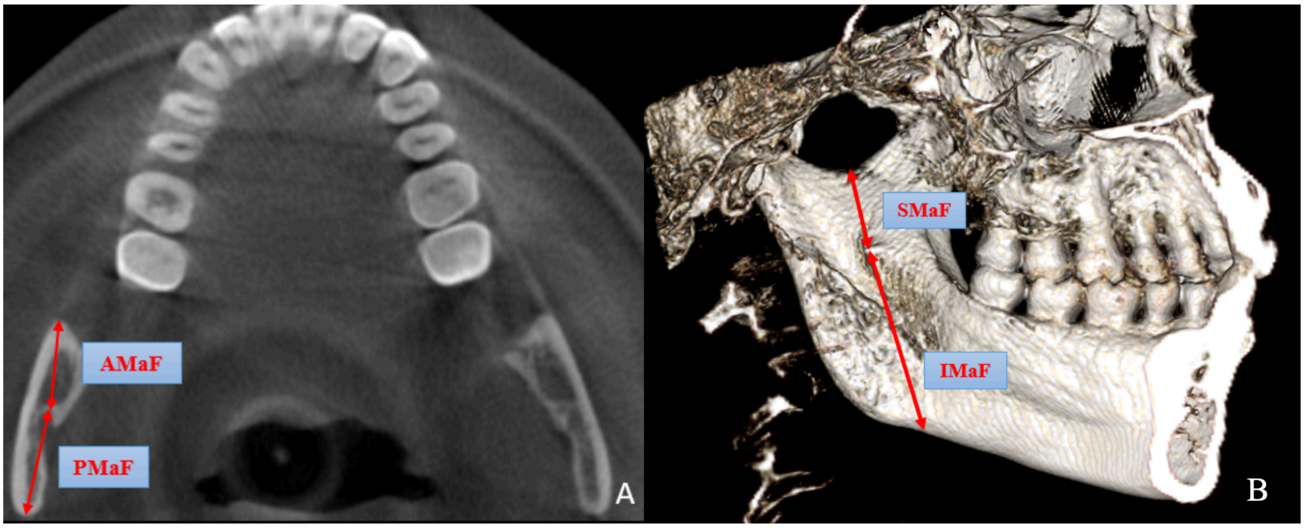
All CBCT images were evaluated in a darkroom by one of the observers. Of the images, 20% (35 cases) were measured by both observers to test the reliability of measurements and assessed with

Interclass Correlation Coefficient. Because a single software programme had not been able to provide both 2D and 3D anatomical measurements, Vision software of the I-CAT Next Generation (Imaging Sciences International, Hatfield, USA) and Anatomage Vivo Dental software version 5.2 (Anatomage, Inc. California, USA) were used on a desktop PC and viewed on a 1920 pixels × 1080 pixels resolution Dell liquid crystal display monitor. Optimal brightness and contrast were set for standardization.

Metric values were measured in millimeters in sagittal and coronal sections using the Anatomage Vivo Dental Software's distance tool. The measurements were made in different coronal and axial orthogonal planes of the scans after selecting the smallest slice thickness of 0.25 mm. Additionally, 3D reconstruction metrics were obtained using the Vision Software. All metrics were selected upon high quality validation and measurability in CBCT images of dental patients. There are many studies in the literature using similar parameters for different ethnic groups to determine sex.[5,16–19]

For horizontal and vertical localization of the mandibular foramen, four metrics were measured in the axial plane, of which the mandibular foramen width was the widest. First, the distance from the most anterior point of the mandibular foramen to the most anterior part of the mandibular ramus was measured and recorded as the anterior mandibular foramen (AMaF). Second, the distance from the most anterior point of the mandibular foramen to the most posterior part of the ramus was measured and recorded as the posterior mandibular foramen (PMaF; Figure 1-A). Third, the distance from the lingula of the mandible to the most inferior point of mandibular notch was measured and recorded as the superior mandibular foramen (SMaF). Fourth, the distance between the lingula of the mandible and the antegonial notch was measured and recorded as the inferior mandibular foramen (IMaF; Figure 1-B).

Figure 1. The position and metrics of the mandibular foramen.



For horizontal and vertical localization of the inferior alveolar canal, four metrics were measured in the coronal plane at the region of the first molar bifurcation. First, the distance from the most superior point of the inferior alveolar canal to the midpoint of the alveolar ridge crest was measured and recorded as the superior inferior alveolar canal (SIAC). Second, the distance from the most inferior point of the inferior alveolar canal to the inferior border of the mandible was measured and recorded as the inferior antegonial alveolar canal (IIAC). Third, the distance from the most lingual point of the inferior alveolar canal to the mandibular lingual cortical plate was measured and recorded as the lingual inferior alveolar canal (LIAC). Fourth, the distance from the most buccal point of the inferior alveolar canal to the mandibular buccal cortical plate was measured and recorded as the buccal inferior alveolar canal (BIAC; Figure 2).

For horizontal and vertical localization of the mental foramen, four metrics were measured in the coronal section, of which the mental foramen was widest. First, the distance from the most superior point of the mental foramen to the midpoint of the alveolar ridge crest was measured and recorded as the superior mental foramen (SMeF). Second, the distance from the most inferior point of the mental foramen to the lowest point of the inferior border of the mandible was measured and recorded as the inferior mental foramen (IMeF; Figure 3-A). Third, the distance from the most anterior point of the mental foramen to the most anterior point of the mentum was measured and recorded as the anterior mental foramen (AMeF). Fourth, the distance from the most posterior point of the mental foramen to the most protruding distal point of the mandibular ramus was measured and recorded as the posterior mental foramen (PMeF; Figure 3-B).

Figure 2. The position and metrics of the mandibular canal.

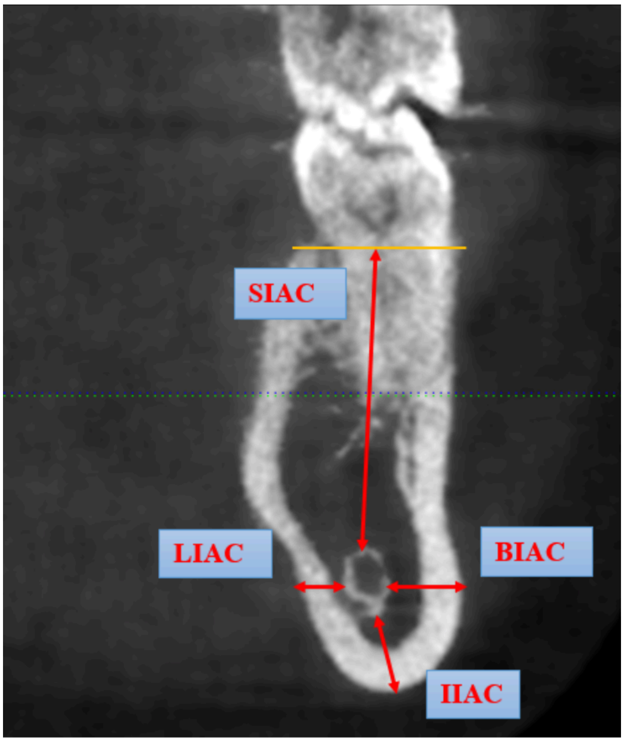
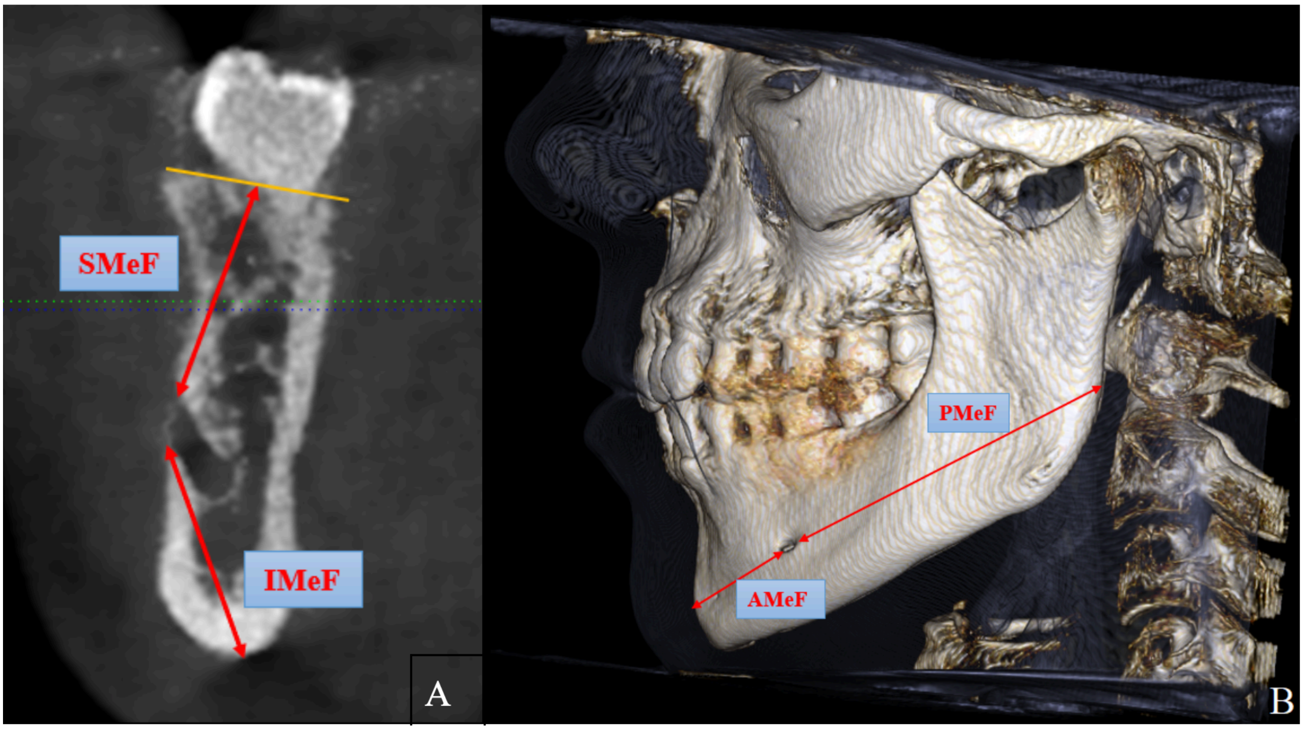


Figure 3. The position and metrics of the mental foramen.



To investigate the difference of intermental distance between the sexes, two measurements were made. In axial section, the linear distance between right and left mental foramen was measured from the most lingual points and recorded as the intermental linear length (ILL; Figure 4-A). The arch distance between the two mental foramina was measured from the labial side and recorded as the intermental arch distance (IAD; Figure 4-B).

In addition to all these metrics, the inferior alveolar canal diameter was measured in the region of first molar bifurcation. The buccolingual distance was measured from the furthest buccal to lingual points and recorded as the buccolingual mandibular canal diameter (BLMaCD). The superoinferior distance was measured from the farthest superior to inferior point and recorded as the superoinferior mandibular canal diameter (SIMaCD; Figure 5).

The above-mentioned metrics relative to their corresponding software are demonstrated in Table 1.

Fig. 4: The metrics of intermental linear length (A) and intermental arch distance (B).

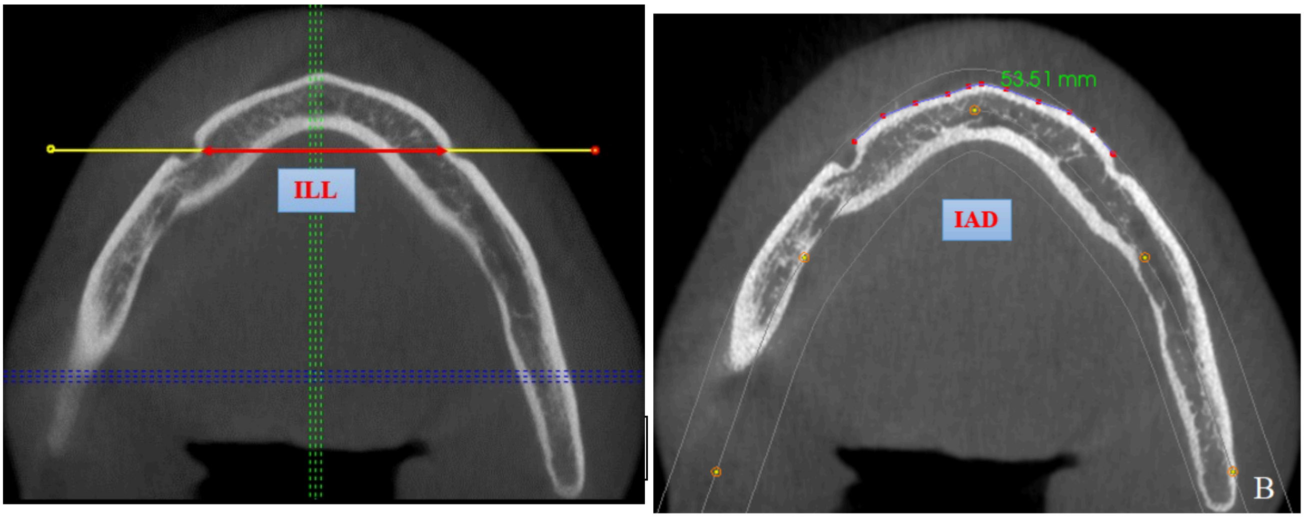


Figure 5. The metrics of mandibular canal diameters.

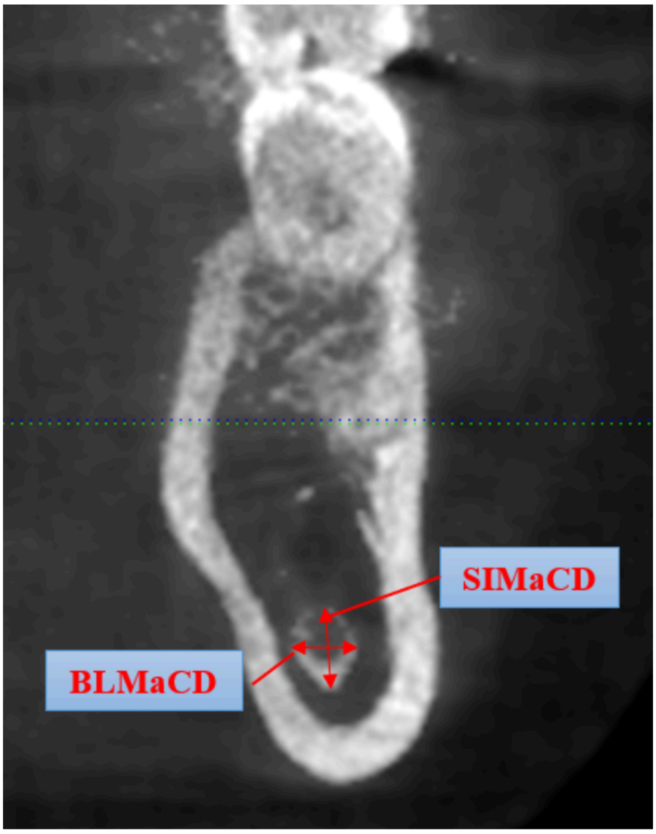


Table 1: Classification of parameters by software and sections.

Vision /I-CAT Next Generation		**Anatomage /In-Vivo Dental Software**
Axial Section	**Coronal section**	**Measurements on 3D reconstruction and intermental arc distance**
AMaF, PMaF, ILL	SIAC, IIAC, LIAC, BIAC, BLMaCD,SIMaCD, SMeF, IMeF	SMaF, IMaF, AMeF, PMeF, IAD

AMaF: Anterior mandibular foramen, PMaF: Posterior mandibular foramen, SMaF: Superior mandibular foramen, IMaF: Inferior mandibular foramen, SIAC: Superior inferior alveolar canal, IIAC: Inferior inferior alveolar canal, BIAC: Buccal inferior alveolar canal, LIAC: Lingual inferior alveolar canal, SMeF: Superior mental foramen, IMeF: Inferior mental foramen, AMef: Anterior mental foramen, PMef: Posterior mental foramen, ILL: Intermental linear length, IAD: Intermental arc distance, BLMaCD: Buccolingual mandibular canal diameter, SIMaCD: Superoinferior mandibular canal diameter.

STATISTICAL ANALYSIS

To assess the data's normality, the Shapiro–Wilk test was applied to demonstrate the appropriate test for the correlation and comparative analyses. Data that were not normally distributed required the use of the nonparametric Mann–Whitney U test, whereas normally distributed data required the use of the parametric Student's t-test to assess the differences between males and females. A logistic regression model was used to determine which predictors were effective in categorizing male and female mandibles, and the concordance index was calculated. To assess the diagnostic capabilities of the predictors, an optimal cut-off value for each predictor was established according to the Youden index method. The sensitivity, specificity, positive and negative predictive values, and accuracy were also calculated for each predictor. The receiver operating characteristic (ROC) curve and area under the curve (AUC) were calculated, and the AUCs were compared using the DeLong test to determine whether the indicators exhibited statistically significant differences in diagnostic accuracy. A *p*-value of less than 0.05 was defined as statistically significant.

Intraclass correlation coefficients (ICCs) were calculated to determine the inter-observer levels of agreement. Of the data, 20% were measured by both researchers to determine the reliability of measurements.[20] Inter-observer agreement was evaluated using Landis and Koch's scale (< 0, no agreement; 0–0.20, slight agreement; 0.21–0.40, fair agreement; 0.41–0.60, moderate agreement; 0.61–0.80, substantial agreement; 0.81–1.00, almost perfect agreement).[21]

RESULTS

The total number of the study sample consisted of 176 individuals ranged between 18–60 years old. Of the 176, 71 (40.3%) were males, and 105 (59.7%) were females.

Of the data calculated by ICC, 20% were measured by both researchers to determine the measurement reliability. Strong and very strong levels of inter-observer agreement were found. When considering all parameters, inter-observer agreement was found to be 0.87. These results indicated high reliability and reproducibility for evaluated measurements (Table 2).

Table 2. Inter-observer reliability as indicated by intraclass correlation coefficients (ICCs) with 95% confidence intervals (CIs) and *p*-values.

Inter-observer agreement	ICC	95%	P	Level of agreement
AMaF	0.98	0.97-0.99	<0.05	Very strong
PMaF	0.98	0.97-0.99	<0.05	Very strong
SMaF	0.98	0.96-0.98	<0.05	Very strong
IMaF	0.98	0.96-0.99	<0.05	Very strong
SIAC	0.98	0.96-0.98	<0.05	Very strong
IIAC	0.97	0.94-0.98	<0.05	Very strong
BIAC	0.95	0.91-0.97	<0.05	Very strong
LIAC	0.92	0.85-0.95	<0.05	Very strong
SMeF	0.98	0.97-0.99	<0.05	Very strong
IMeF	0.97	0.94-0.98	<0.05	Very strong
AmeF	0.98	0.96-0.99	<0.05	Very strong
PMeF	0.99	0.14-0.75	<0.05	Very strong
ILL	0.98	0.97-0.99	<0.05	Very strong
IAD	0.97	0.94-0.98	<0.05	Very strong
BLMaCD	0.89	0.80-0.94	<0.05	Strong
SIMaCD	0.90	0.81-0.94	<0.05	Strong

SD: Standard deviation, AMaF: Anterior mandibular foramen, PMaF: Posterior mandibular foramen, SMaF: Superior mandibular foramen, IMaF: Inferior mandibular foramen, SIAC: Superior inferior alveolar canal, IIAC: Inferior inferior alveolar canal, BIAC: Buccal inferior alveolar canal, LIAC: Lingual inferior alveolar canal, SMeF: Superior mental foramen, IMeF: Inferior mental foramen, AMef: Anterior mental foramen, PMef: Posterior mental foramen, ILL: Intermental linear length, IAD: Intermental arch distance, BLMaCD: Buccolingual mandibular canal diameter, SIMaCD: Superoinferior mandibular canal diameter.

Aside from SMaF, the mean values of all measurements were higher in males than in females. Additionally, all measurements, besides SIMaCD, showed statistically significant differences between males and females. Comparison of mean differences between males and females are shown in Table 3 and illustrated in Figure 6.

Table 3. Descriptive data of all studied linear measurements according to sex.

	MALE				FEMALE				
VARIABLE	MEAN	SD	MEDIAN	RANGE	MEAN	SD	MEDIAN	RANGE	P value
AMaF	16.15	2.60	16	11.54-21.74	15.38	2.13	15.28	10.41-20.70	[1]0.040*
PMaF	18.20	2.20	18.05	14.05-24.45	16.02	2.22	15.82	11.99-24.14	[1]0.000*
SMaF	15.35	2.32	15	10.60-22.70	16.02	2.22	13.80	8.00-22.57	[1]0.002*
IMaF	35.56	6.27	36.40	23.30-48.30	31.88	3.00	32.00	24.40-38.59	[2]0.000*
SIAC	17.30	2.71	17.77	8.53-22.40	15.98	2.51	16.40	7.47-21.26	[1]0.001*
IIAC	7.71	2.30	7.60	2.68-16.77	6.82	1.93	6.60	3.22-14.01	[1]0.006*
BIAC	5.50	1.18	5.26	2.68-8.59	5.12	1.26	4.82	2.88-8.74	[1]0.043*
LIAC	3.40	0.59	3.43	2.00-4.83	3.22	0.54	3.22	2.00-4.35	[1]0.047*
SMeF	14.38	2.49	14.36	7.52-22.97	13.30	1.87	13.24	6.80-16.95	[1]0.001*
IMeF	14.35	1.68	14.49	10.85-19.07	13.55	1.86	13.54	9.81-23.97	[2]0.001*
AMeF	20.53	4.15	19.80	12.80-30.21	19.06	3.62	18.00	13.40-29.30	[1]0.014*
PMeF	63.30	0.74	63.80	61.74-64.72	59.25	0.38	59.40	58.50-60.01	[2]0.000*
ILL	43.83	2.71	44.00	39.05-50.59	42.43	2.68	42.39	33.84-51.70	[1]0.001*
IAD	51.38	3.72	51.39	44.03-62.51	49.71	3.94	49.40	40.97-62.80	[1]0.047*
BLMaCD	3.10	0.65	2.91	2.00-5.20	2.90	0.62	2.83	1.65-4.78	[1]0.005*
SIMaCD	3.23	0.73	3.20	1.77-5.75	3.04	0.64	2.91	1.60-5.40	[1]0.075

[1] Student's t-test; [2] Mann–Whitney U test
SD: Standard deviation *: $p < 0.05$

Correlation analysis was performed to test the relationship between parameters used for logistic regression. According to analysis, IAD and ILL were found highly correlated with each other. To avoid statistical errors, IAD and ILL were excluded from the model.

Logistic regression analysis results showed that the PMaF, IIAC, and IMaF parameters were effective in determining sex. The negative standardized regression coefficient indicated the mandibular landmark of the male sex, and the positive standardized regression coefficient indicated the mandibular landmark of the female sex. According to the logistic regression analysis, sex determination can be achieved with a mean accuracy of 84.1%. Whereas this rate was 76.1% for men, it was 89.5% for women. Application of likelihood analysis to the fourteen variables resulted in the following logistic function formulation:

$$\text{Logit}: 27.88 - (0.13 \times AMaF) - (0.31 \times PMaF) - (0.05 \times SMaF) - (0.13 \times IMaF) - (0.10 \times SIAC) - (0.25 \times IIAC) - (0.29 \times BIAC) - (0.56 \times LIAC) - (0.14 \times SMeF) - (0.11 \times IMeF) - (0.04 \times AMeF) - (0.06 \times PMeF) - (0.07 \times BLMaCD) - (0.58 \times SIMaCD)$$

The highest diagnostic accuracy using cut-off values among the fourteen parameters disclosed that it was associated primarily with IMaF (76%), followed by PMeF (73%) and PMaF (70%). Additionally, overall prediction of all fourteen parameters revealed that the accuracy rate for the identification of female and male mandibles is 80% (Table 4 and Figure 7). When fourteen parameters were combined, a concordance index of 91% was found.

Figure 6. Mean measurements in males and females. The error bars indicate values of standard deviations.

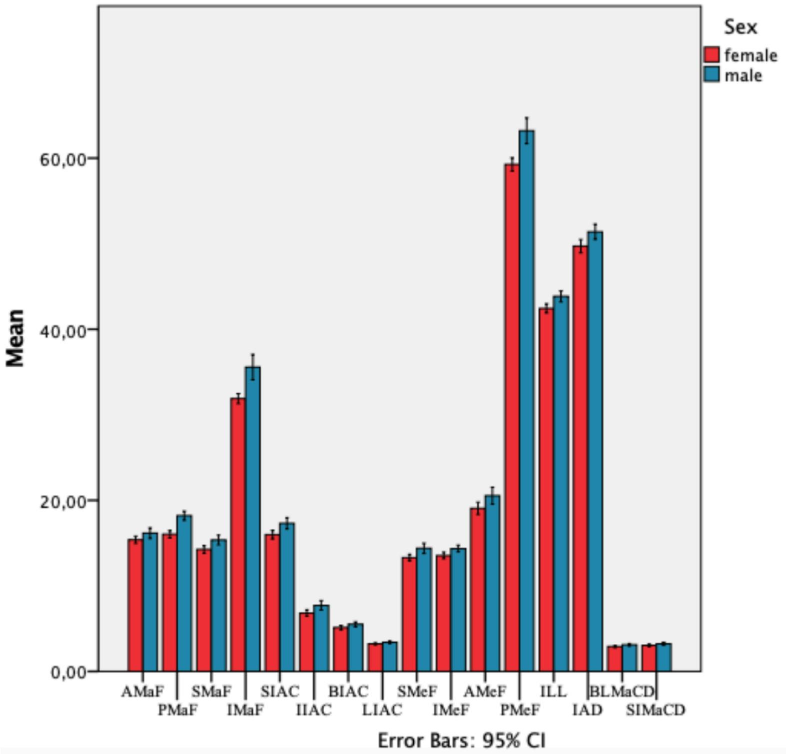
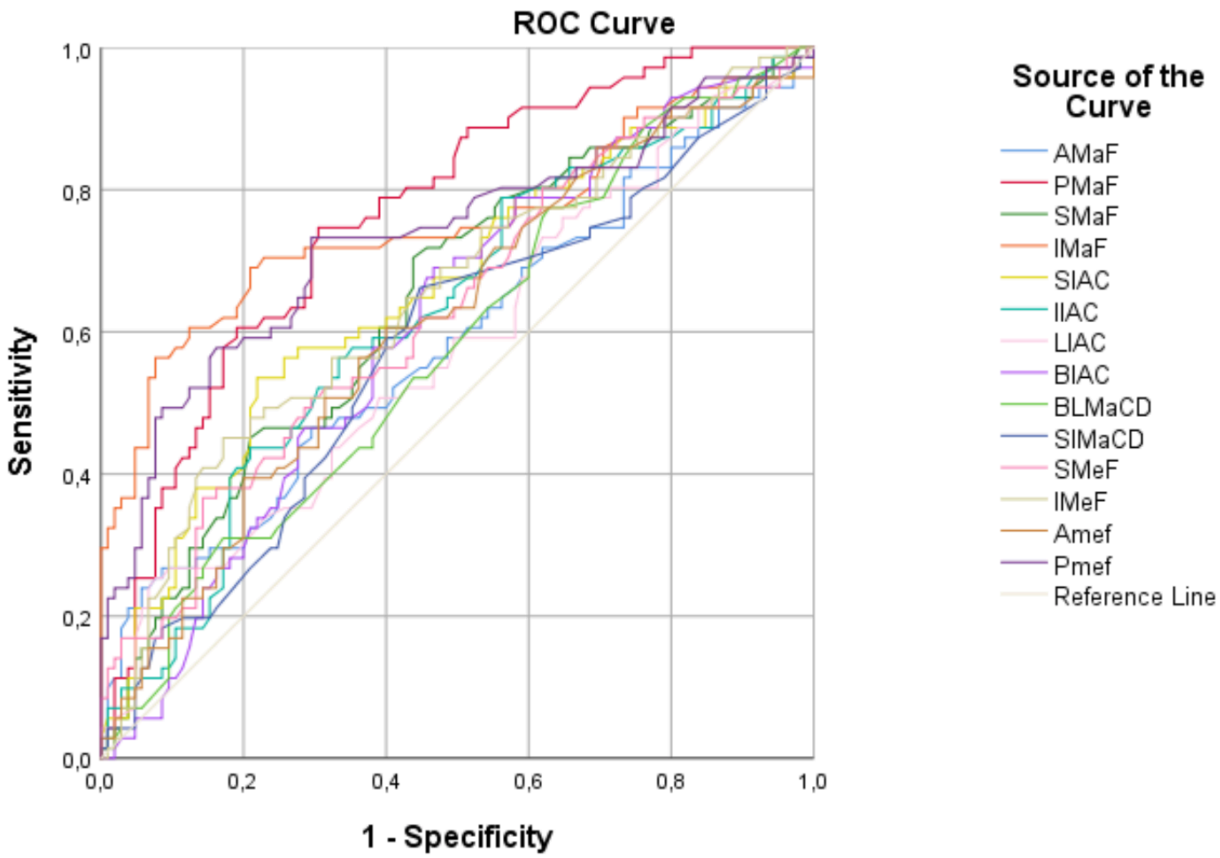


Table 4: Sensitivity, specificity, positive predictive value, and negative predictive value of the fourteen linear measurements selected for sex prediction at the optimal cut-off.

	Cut-off	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Accuracy	AUC	95% CI	P
AMaF	18.86	0.24	0.94	0.73	0.64	0.66	0.59	0.50-0,68	0.050
PMaF	20.72	0.52	0.83	0.67	0.72	0.70	0.77	0.70-0,84	0.001
SMaF	18.1	0.29	0.86	0.58	0.64	0.63	0.65	0.56-0.73	0.001
IMaF	38.3	0.59	0.87	0.76	0.76	0.76	0.75	0.67-0.83	0.001
SIAC	21.05	0.34	0.87	0.63	0.66	0.65	0.66	0.57-0.74	0.001
IIAC	11.6	0.18	0.88	0.52	0.62	0.60	0.62	0.54-0.71	0.005
BIAC	6.43	0.13	0.89	0.43	0.60	0.58	0.61	0.53-0.69	0.013
LIAC	3.99	0.17	0.95	0.70	0.63	0.64	0.58	0.49-0.67	0.078
SMeF	16.56	0.30	0.87	0.60	0.65	0.64	0.63	0.55-0.71	0.004
IMeF	15.64	0.28	0.9	0.67	0.65	0.65	0.65	0.57-0.73	0.001
AMeF	27.33	0.23	0.86	0.52	0.62	0.60	0.61	0.53-0.70	0.011

PMeF	68.44	0.51	0.88	0.73	0.72	0.73	0.73	0.65-0.81	0.001
BLMaCD	4.49	0.11	0.90	0.45	0.60	0.59	0.58	0.50-0.67	0.004
SIMaCD	4.73	0.11	0.94	0.57	0.61	0.61	0.58	0.49-0.67	0.078
All	-	75.2	88.4	81.2	84.2	0.80	0.68	-	-

Fig. 7: Receiver operating characteristic curves of the predictors that were included, both individually and combined, in the final logistic regression model
AUC: area under the receiver operating characteristic curve; CI: confidence interval.



DISCUSSION

Human identification is one of the main interests of forensic science. In accordance with this purpose, three important determinants have been studied: age, sex, and stature.[11] Forensic odontologists examine teeth and skull traits to conduct sex estimation. Iscan et al. measured buccolingual dimensions of maxillary and mandibular teeth separately, and the most sexually dimorphic tooth was found to be the canine in both jaws.[22] As a bony structure, the mandible is also regarded as a sexually dimorphic bone by forensic odontologists.[23] Mandibular morphological traits vary by population and race.[14] There are several publications on the mandible that provide forensic databases for different populations. In previous articles, the wide range of metrics that belong to mandibular parameters were significantly higher in males compared to females regardless of the method of measurement.[16,18,24–26] In the current study, aside from SIMaCD, all parameters were found to be statistically significant. Previous articles and the current study showed similar statistical results and studied similar parameters, which are shown in Table 5.[5,16–19]

Table 5: Comparison of the results of different parameters in different studies.

	Saraswathi et al. 50 CBCT (25 females 25 males)	Gamba et al. Brazilian 160 CBCT (86 females 74 males)	Mansımranjıt et al. 73 CBCT (32 females 41 males)	Amin Jordanians 270 CBCT (123 females 147 males)	Mousa et al. Egyptian 210 CBCT (120 females 90 males)	Current study Turkish 176 CBCT (105 females 71 males)
Parameters in common	AMaF, PMaF, SIAC, IIAC, LIAC, BIAC, SMeF, IMeF	AMaF, PMaF, SIAC, IIAC, LIAC, BIAC, SMeF, IMeF,	SIAC, IIAC, LIAC, BIAC, SMeF, IMeF	AMeF (D3), PMeF (D4), AMaF (D5), PMaF (D6), SMaf (D7), IMaF (D8)	SMeF, IMeF, SIAC, IIAC, BIAC, LIAC, AMaF, PMaF	AMaF, PMaF, SMaF, IMaF, SIAC, IIAC, LIAC, BIAC, SMeF, IMeF, AMeF, PMeF, ILL, IAD, BLMaCD, SIMaCD
Parameters which had statistically significant difference between males and females	AMaF, PMaF, SIAC, IIAC, BIAC	All measurements	SMeF and SIAC	PMeF (D4), PMaF (D6), IMaF (D8)	All of the linear measurements besides BIAC and IIAC	All measurements besides SIMaCD
Accuracy level of parameters	-	-	-	D4 66% D8 57% Total accuracy of 6 predictors is 86.7%	IIAC (73%) IMeF (72%) SIAC, IMeF, and PMaF (65%), LIAC (60%) When the 6 predictors were combined total accuracy is 78%	IMaF (76%), PMeF (73%), PMaf (70%) When the 14 predictors were combined total accuracy is 80%

In this study, the accuracy rate of whole parameters was 80%. The overall measurement outcomes revealed accuracy rates of 78–86.7%, including the present study.[17,19] Although Mousa et al.'s sample size was larger than this study, the number of inspected measurements was higher in this study, and its results revealed similar accuracy rates. According to Mousa et al., the highest accuracy rate was associated with IIAC (73%), followed by IMeF (72%), followed by SIAC, IMeF and PMaF at the same accuracy rate (65%), whereas LIAC (60%) was associated with the lowest accuracy rate.[17] In the current study, IMaF had the highest accuracy rate. Gopal et al. measured SIAC from the occlusal plane of caries and restoration free mandibular first molars.[18] In the current study, the most superior buccal and lingual points of the alveolar crest were preferred for the same measurement to avoid crown height distinctiveness. Additionally, patients with periodontitis were excluded from the study to achieve accurate measurements. Although different reference points were chosen, SIAC showed statistically significant differences in both experiments. Rashid et al. performed similar measurements with the current study using panoramic images.[27] Their measurements corresponded to SMeF, IMeF, SMaF and SMaF+IMaF. SMaF and SMaF+IMaF were found to be the most sexually dimorphic parameters.

Panoramic tomography (PTG) is a 2D imaging modality used in dental practice. This method has a number of disadvantages compared to 3D imaging modalities such as magnification, elongation, geometric distortion, and superposition.[28–29] Suragimath et al. performed measurements to evaluate sexual dimorphism of the mental foramen using PTG.[30] Unlike Rashid's study, a number of horizontal measurements were included in the current study. Because of distortion and overlapping, horizontal measurements are not dependable on PTG.[28–29] In view of these disadvantages, we utilized CBCT in this study. Because these anthropological and forensic studies are population specific, we examined mandibles specifically belonging to the Turkish population.[31]

In the coronal plane, mandibular canal diameters were measured at the level of the first mandibular molar. BLMaCD demonstrated statistical significance. There has been no up to date article that has assessed mandibular canal diameters in terms of sexual dimorphism; therefore, more research is required to extensively evaluate this topic.

Amin found an accuracy rate of 91.3% for males and 83.8% for females in the Jordanian population.[26] In this study, the accuracy rates for sex determination from mandibular measurements were 89.5% in females and 76.1% in males. These results revealed that female mandibles were correctly identified more frequently than male mandibles.

CONCLUSIONS

The highest diagnostic accuracy rate using cut-off values among the fourteen parameters was primarily associated with IMaF (76%), followed by PMeF (73%) and PMaF (70%). Furthermore, the overall prediction of all fourteen parameters revealed that the accuracy rate for the identification of female and male mandibles is 80%. The accuracy rates of sex determination from mandibular measurements were 89.5% in females and 76.1% in males. In conclusion, these mandibular landmarks showed that they could be used as reliable indicators of sexual dimorphism.

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