JOURNAL OF CLINICAL AND BIOMEDICAL SCIENCES

ORIGINAL ARTICLE

OPEN ACCESS

Received: 20.10.2022
Accepted: 30.11.2022
Published: 22.12.2022

Citation: Revanth RB, Harini B, Anil KS, Yashas U, Suraj HS, Rishi P. Computed Tomographic Evaluation of Mandibular Ramus for Gender Identification. J Clin Biomed Sci 2022; 12(4): 142-146. https://doi.org/10.58739/jcbs/v12i4.124

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Funding: None

Competing Interests: None

Published By Sri Devaraj Urs Academy of Higher Education, Kolar, Karnataka

ISSN
Print: 2231-4180
Electronic: 2319-2453

Computed Tomographic Evaluation of Mandibular Ramus for Gender Identification

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Abstract

Background: The ability to identify sex is essential for identification and plays a significant role in forensic medicine and medico legal investigations. Identification's first purpose is sex determination, which is followed by estimations of age, size, and ethnic population, all of which are influenced by the gender. When identifying morphologic characteristics for gender determination, gender analysis and estimate are carried out with almost 90% to 100% accuracy using a whole skeleton. On the other hand, partial or fragmented bones and badly injured bodies, such as in the case of a mass tragedy, might be challenging to analyse. The skull is the second-best marker for gender identification after the pelvis. However, as the mandible is the biggest bone of the skull, it may be crucial in circumstances when a whole skull is not recovered for gender identification. **Objectives:** To ascertain how computed tomography can be utilised to know a person's gender with the help of mandibular measurements. **Methods:** The study was done with the Siemens Somatom 16 slice CT machine. Patients who match the inclusion criteria and have received CT for a wide range of reasons will be considered. Various measurements such as Condylar height, Maximum ramus breadth, Minimum ramus breadth projective height of ramus, Coronoid height shall be measured. Data analysis must be done with SPSS 20. For comparisons between the right and left sides, the student t-test shall be applied. **Results:** 58 individuals between the ages of 18 and 35 (29 females, mean age, 26.3, 29 males, men age, 26.9 & overall mean for both sexes was 26.6 years). In the present study, mean score of five distinct mandibular parameters were calculated. All mandibular ramus variables on CT models were discovered to exhibit a statistically significant gender difference (p = 0.001). It was discovered that the mean condylar height was 64.5 mm in men and 59.56 mm in women, which was a significant (P = 0.001). It was noteworthy (P = 0.001) that whereas

the mean maximal ramus width was 35.0 mm in females and 38.0 mm in men. Males and females had different mean values for the minimum ramus width, which were 31.3 mm and 28.8 mm, respectively (P = 0.001). Males and females had mean ramus projection height measurements of 52.38 mm and 47.91 mm, respectively. This difference was significant (P = 0.004). The mean coronoid height was 63.42 mm in men and 56.80 mm in women, which was significant (P = 0.001). 27 out of 29 female mandibular measures correctly identified the gender, with a prediction rate of 96.4%, and 27 out of 29 male mandibular measurements correctly identified the gender, with a prediction rate of 96.4%. The threshold for determining a per- son's sex. As a cut-off for predicting male sex, values over 62.8 mm for condylar height, 36.9 mm for maximum ramus height, 30.0 mm for lowest ramus height, 50.4 mm for projective ramus height, and 61.3 mm for coronoid height can be used. **Conclusion:** In forensic medicine, the assessment of mandible, particularly the ramus area, plays a crucial factor in determining gender. Future research should evaluate gender determination recommendations using various criteria in bigger sample sizes and across a range of age groups. Although there are differences in ramus measurements between both the genders, there are variations in measures between societies. Therefore, to accurately identify gender from skeletal remains, criteria that are unique to each population must be developed. We think the results of this study will be helpful to radiologists making diagnoses and surgeons working on the mandible and facial area.

Keywords: Mandible; Determination of gender; Paranasal sinuses

Introduction

Identification requires the capacity to recognise sex, which is also important in forensic anthropology and medico legal investigations. The primary goal of identification is sex determination, which is followed by age, stature, assessment of ethnic population, and other sex-dependent characteristics. When identifying morphologic characteristics for gender determination, gender analysis and estimate are carried out with 90% to 100% accuracy using a whole skeleton.[1,2] On the other hand, when fragmentary or fragmented bones and bodies are extensively damaged, as in the case of a tragic tragedy,[3] it may be challenging to analyse for the identification of identity. After the pelvis, the skull is regarded as the second-best bone for gender identification. However, as the mandible is the largest, stiffest, and most dimorphic bone in the skull, it could be essential to discern gender in situations when a whole dry skull cannot be found. It possesses a number of dimorphic features that may be used to infer gender and is sensitive to changes in young people's development. Given that the masticatory forces utilised differ depending on gender, it is known that the relative development (size, lengths, force, and angulation) of the mastication muscles has an impact on the mandibular ramus dimorphism.[4,5]

Variations in the mandible can be utilised to determine a person's gender and are acceptable for sexual dimorphism, according to Humphrey et al.[6] The mandibular condylar and rami, which display gender distinctions, have seen the most morphological alteration. The researchers employed morphological, quantitative, and molecular criteria. Morphological features can be seen and observed. Metric parameters, on the other hand, are reliable, repeatable, and based on measurements of bone fragments. Recent studies have discovered that skeletal measures are useful in determining gender features.

Thus, it is crucial to find trustworthy selective analytical methods for dimorphic fragment bones.[7]

Among scientists, there have been debates over the reliability of these measurements. Regarding the dimorphic properties of several measurements used in prior research on jaws, there were disagreements in the literature.

Furthermore, Varied populations have different skeletal traits, which is widely acknowledged. Because of this, each group needs a self-specific gender evaluation criterion.

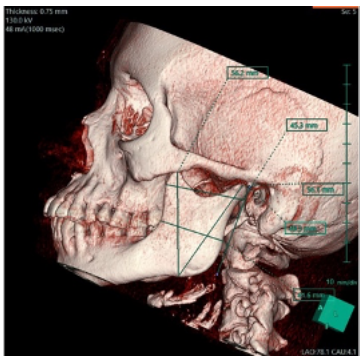
Utilizing Fuji Synapse software, computed tomography was done to take the measurements. Medical scanning is a profession that is continually developing thanks to new techniques. In the discipline of forensic science, computer-assisted work methods are gradually becoming more and more common. Studies found in the literature show that computed tomography (CT) offers superior accuracy, repeatability, and reliability over traditional methods.[8]

Materials & Methods

- Design of study – Hospital based prospective study.
- Total number of study subjects – 58 (29 males & 29 females).
  - Inclusion criteria- Patients undergoing CT Brain / PNS for reasons not included in the exclusion criteria.
  - Exclusion criteria- Patients with facial fractures.
    - Bone tumors
    - Metabolic disorders of the bone
    - Growth disorders
    - Severe osteoporosis
    - Missing teeth

The study was done with the Siemens Somatom 16 slice CT machine. Patients who have undergone CT for various reasons and who meet the inclusion criteria were into consideration**.** Various measurements such as Condylar height, Maximum ramus breadth, Minimum ramus breadth projective height of ramus, Coronoid height shall be measured on 3D surface shaded display image.

Analysis & Statistical Methods



Okkesim & Erhamaza.[9] has reported the mean (SD) projective height of ramus in females to be 48.0 (7.26) and among males to be 53.91 (8.72). Assuming alpha error of 5% (95% Confidence limit), Power of 80%, ratio of males: females = 1:1, the minimum required sample size to discriminate the gender based on the mandibular ramus was 58 subjects (29 males and 29 females).

The sample is derived from the following formula:

$$\text{Sample size (n)} = \frac{2{S_p}^2\left[z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right]^2}{{\mu_d}^2}; \quad S_p^2 = \frac{{S_1}^2 + {S_2}^2}{2}$$

where, S_1: Standard deviation in the first group
S_2: Standard deviation in the second group
μd : Mean difference between the samples
α: Significance level 1-β: Power

Statistical Analysis

Microsoft Excel was used for data entry, and the statistical package (SPSS) standard version 20 was been used for analysis. The patient's whole sociodemographic profile and clinical features was summed up using proportions (%) for categorical variables and means (SD) for continuous variables. The student's t test will be used to compare continuous variables (condylar height, max ramus breadth, min ramus breadth, projective height of ramus, and coronoid height) between groups. To determine appropriate cut-offs for predicting gender from the mandibular ramus, a ROC curve will be constructed. The chosen cut-sensitivity off's and specificity will be presented with a 95% confidence interval. Using the Chi square test, categorical variables will be compared between study groups. Statistical significance will be determined by a P-value of less than 0.05.

Results

Table 1. Comparison of mandibular measurements between gender

	Female (N=29)		Male (N=29)		p-value
	Mean	SD	Mean	SD	
Condylar height	59.56	0.86	64.55	1.2	<0.001
Maximum Ramus height	35.07	0.76	38.05	0.48	<0.001
Minimum Ramus height	28.88	0.57	31.31	0.53	<0.001
Projective height of ramus	47.91	0.85	52.38	0.84	<0.001
Coronoid height	56.80	0.55	63.42	0.73	<0.001
Age	26.96	4.29	26.37	4.81	0.626

Table 2. Canonical linear discriminant analysis

Canon. Corr.	Eigen-value	Likeli-hood ratio	F	Probability value
0.990	50.77	0.019	528.08	<0.001
	Standardised discriminant co-efficient	**canonical function**		**Canonical Structure**
Condylar height	-0.49836			-0.34075
Maximum Ramus height	-0.30169			-0.33232
Minimum Ramus height	-0.16863			-0.31218
Projective height of ramus	-0.17899			-0.37649
Coronoid height	-0.84351			-0.72305

Table 3. Prediction accuracy

		Classified (sex)		Total
		Female	Male	
True status (sex)	Female	27 (96.4%)	2 (3.6%)	29 (100.0%)
	Male	2 (3.6%)	27 (96.4)	29 (100.0%)
	Total	29 (50.0%)	29 (50.0%)	58 (100.0%)

Table 4. Cut-off for predicting sex using mandibular measurements

	Cut-off	Sensitivity	Specificity
Condylar height	62.8	96%	92%
Maximum Ramus height	36.9	97%	95%
Minimum Ramus height	30.0	96%	91%
Projective height of ramus	50.4	92%	88%
Coronoid height	61.3	90%	86%

Defined cut-offs perfectly predict the discrimination between male and females sex using mandibular measurements 58 patients, ages 18 to 35, with a mean of 26.6 years (29 females, mean age 26.3 ; 29 males, mean age 26.9). In the current study, mean scores for five distinct mandibular parameters were calculated. Table 1 displays the five mandibular ramus measurement. All mandibular ramus variables on CT models were discovered to exhibit a significant difference. (p 0.001). (Table 2).

The mean condylar height was significant (P = 0.001), measuring 64.5 mm in men and 59.56 mm in women. The mean maximal ramus width in men was 38.0 mm and 35.0 mm in females was significant (P = 0.001). Both the genders had different mean minimum ramus widths of 31.3 2.89 mm and 28.8 2.88 mm (P = 0.001).

Men and women had mean projection heights of the ramus that were significantly different (P = 0.004) at 52.38 mm and 47.91 mm, respectively. The mean coronoid height was found to be significant (P = 0.001), measuring 63.42 mm in men and 56.80 mm in females. Fischer's exact test provided the variables needed for discriminant function analysis, which are displayed in Table 2. 27 samples out of 29 female mandibular measures correctly identified the gender, with a prediction accuracy rate of 96.4%, and 27 samples out of 29 male mandibular measurements correctly identified the gender, with a prediction accuracy rate of 96.4%. (Table 3).

In Table 4 we can see the cut-off for predicting the sex of the individual. Values above 62.8 mm for condylar height, 36.9 mm for maximum ramus height, 30.0 mm for minimum ramus height, 50.4 mm for projective height of ramus, 61.3 mm for coronoid height can be taken as cut-off for predicting male sex.

Discussion

Using the remaining jaws and teeth, forensic dentists may determine the gender, which is one of the field's most crucial tasks. Mandible is used for measurements because they still contain a lot of healthy bone and significant sexual dimorphism. This study aimed to discover the morphometric features of mandible in the south Indian population and evaluate the effectiveness of methods for determining gender. The results showed that all five parameters were assessed using the mandibular ramus. a gender diversity gap that is statistically significant.[9]

The mandible demonstrates considerable sexual dimorphism since the variables measured using CT showed statistically significant sex differences be- tween the sexes. The mandible had the greatest degree of sexual dimorphism in terms of minimum ramus breadth, condylar height and maximum ramus height.

A research on the mandibular posterior flexure as a sex diagnostic tool was conducted by Shivaprakash and Vijaykumar.[10] Sex was accurately diagnosed in 44 out of 55 male mandibles, or with an accuracy rate of 80%, and in 35 out of 49 female mandibles, or with an accuracy rate of 71%.

The numerous cut-offs from our investigation can be used to identify the gender.

Conclusion

In forensic medicine, evaluating the mandible is essential to establishing gender. Studies in the future should assess gender determination suggestions on ramus using various factors, larger sample numbers, and a range of age groups. Although males and females in each society have different ramus measurements, there are also disparities in measurements between societies. Therefore, specific criteria for each population must be created in order to reliably deter- mine

gender. The results of this study, in our opinion, will be beneficial to surgeons, radiologists and forensic medicine experts in making diagnoses.

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