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Morphology of mandible - A two year digital radiographic study

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ABSTRACT

Background: Mandible is a unique single bone often recovered intact during mass disasters.
Aims: To assess whether the specific morphological characteristics of mandible in males and females can be used as an aid for sex determination based on radiographs.
Materials and Methods: A two-year retrospective study was conducted in 200 subjects [100 males and 100 females] using digital radiographs. Profile of chin and morphologic differences in the base of the mandible were assessed using digital lateral cephalogram. Mandibular ramus flexure was assessed from digital Orthopantomogram. The obtained data statistically analysed using SPSS software version 20. Descriptive statistics was analysed. Chi square test was done to determine the association between gender and different parameters. The level of significance set at $p \leq 0.05$.
Results: There is a significant association between chin profile, base of mandible and mandibular ramus flexure with gender. Females have prominent chin compared to males. Males have undulating base of mandible while females have straight base of mandible. Mandibular ramus flexure in males seen at the level of occlusal plane while it is seen above the occlusal plane in females.
Conclusion: There is a morphological difference in the mandible of the males and females.

1. Introduction

Gender determination is an important element in anthropological and forensic studies. Mandible is a strong and durable bone of craniofacial skeleton. Among human bones, Pelvis is the most reliable bone for gender determination. In cases where complete pelvis is absent, mandible can be used as an important aid in identification.Next to pelvis, mandible of skull is the most sexually dimorphic bone. As evident from previous studies various metric and non metric parameters are used to assess the sexual dimorphism in mandible. Non metric or visual traits of mandible are assessed easily and quickly when compared to metric parameters. Metric parameters cannot be used in case of fragmented mandible as in trauma cases. The dense compact bone of mandible helps to maintain its shape for longer duration of time. The shape of mandible can change depending on chewing habits and vary according to different life styles. So different ethnic group can show variations in the morphology of mandible.[1–3] Panoramic radiography and lateral cephalogram are very popular techniques commonly used in routine dental practices to evaluate mandibular and maxillary vital structures. They are suitable to view the integrity of whole dento-facial tissues. These radiographs can be used as a tool to study the morphology of mandible.

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2. Materials and Methods

2.1. Study design

Descriptive study.

2.2. Duration

2 years retrospective study from May 2017 to May 2019.

2.3. Setting

Government Dental College, Alappuzha.

2.4. Sampling method

Convenient sampling technique. All radiographs meeting the inclusion and exclusion criteria were selected for the study.

2.5. Study population

Patients visiting the Out Patient department of Government Dental College, Alappuzha.

2.6. Inclusion criteria

Good quality radiographs of individuals in the age group ranging from 18-40 years were included in the study.

2.7. Exclusion criteria

Mandible with pathology, fracture, developmental disturbances and edentulous mandibles were excluded from the study.

2.8. Data collection tools

Digital Orthopantomogram, lateral cephalogram, software EZ Dent i.

2.9. Data collection procedure

A two-year retrospective study was conducted in 200 subjects [100 males and 100 females] using digital radiographs. Profile of chin and morphologic differences in the base of the mandible were assessed using lateral cephalogram. Mandibular ramus notching was assessed from digital Orthopantomogram.

1. Profile of chin is straight or prominent based on the protrusion observed from lateral view on lateral cephalogram. Profile of chin analysed from the point B to menton on mandible.
2. The base of the mandible is straight or undulating based on the presence or absence of antegonial notch in the lateral cephalogram. Antegonial notch is a surface field of resorption seen on the inferior edge of mandible at ramus body junction.
3. Mandibular ramus flexure at the level of occlusal plane or above the occlusal plane. The right side of mandible was analysed using Orthopantomogram. A tangent was drawn passing through prominent point on posterior outline of condylar head and prominent point on posterior margin of ramus. The posterior margin of ramus traced and the deepest point of ramus notch marked. The height of occlusal plane was marked by a line passing through the most prominent cusp tips of the first and second mandibular molars.

3. Ethics

Ethical clearance (IEC/IRB No: B3/1573(A)/ 2010/TDMCA) was obtained from the institutional ethics committee of Government TD Medical College, Alappuzha. Verbal consent routinely taken from patients visiting Radiology department regarding the use of radiographs for research purpose without revealing their identity.

3.1. Statistics

The obtained data statistically analysed using SPSS software version 20. Descriptive statistics was analysed. Chi square test was done to determine the association between gender and different parameters. The level of significance set at $p \leq 0.05$.

4. Results

4.1. Chin profile

In females 84% had prominent chin while 16% had straight chin. In males 57% has prominent chin while 43% had straight chin. There is a significant association ($p< .001$) between chin profile and gender (Table 1). Female predominantly showed chin prominence while males predominantly showed straight chin.

4.2. Base of mandible

In females 67% had straight base of mandible while 33% had undulating base of mandible. In males 62% had undulating base while 38% had straight base. A significant association($p< .001$) is found between base of the mandible and gender (Table 2). Males predominantly showed an undulating base of mandible while females predominantly showed straight base of mandible.

4.3. Ramus of mandible

In 9% of females, mandibular ramus flexure was absent. In 87% of females ramus flexure was seen at a level above the occlusal plane near condyle while 4% of females show ramus flexure at the level of occlusal plane.

Table 1: Gender* Chin profile

		Chin Profile		Total	Pearson Chi-Square value	P value
		Straight	Prominent			
Gender	Male	43	57	100		
	Female	16	84	100	17.526a	P<0.01
Total		59	141	200		

Table 2: Gender * Ramus flexure

		Base of mandible		Total	Pearson Chi-Square value	P value
		Straight	Undulating			
Gender	Male	38	62	100		
	Female	67	33	100	16.862a	P<0.01
Total		105	95	200		

In 19% of males, mandibular ramus flexure was absent. In 59% of males, ramus flexure was present in the ramus which is seen at the level of occlusal plane while 22% of males show ramus notching at the level above the occlusal plane. There is a significant association (p< .001) between gender and mandibular ramus flexure (Table 3). Males had ramus flexure predominantly seen at the level of occlusal plane while females had ramus flexure predominantly seen at a level above the occlusal plane near condyle.

5. Discussion

Identification of skeletal remains is important in forensic medicine and anthropology. Previous studies show that there are significant ethnic, racial and sexual differences in mandible. These differences are determined by the environmental factors and different growth patterns.[4–7]

In the present study female showed a significant prominent chin profile and male showed straight chin profile. Frieitas et al. found a small chin prominence in blacks compared to whites.[6] Nagaraj et al. found that vertical chin profile is more frequent in both males and females.[2]

In the present study males showed undulating while females showed predominantly straight outline in the base of mandible. In the present stud y rocker shape of contour of base of mandible was not found in both genders. Mandible with convex lower border with contact at a point below second permanent molar is classified as rocker shape mandible.[3] Ongkana and Sudwan in Thai population found that undulating border of mandible was found predominantly in males and straight border of mandible in females.[8] Hue et al. in Korean population found predominantly rocker shaped mandible in males and straight mandibular base in females.[9] Chole et al. in Indian population found that females tend to have a straight lower border of mandible.[10] Nagaraj et al. found rocker shaped mandible in all males and straight base of mandible in females.[2] Deana and Alvis found rocker shaped mandible in both sex and undulating base of mandible was absent in their study sample.[7] Saini et al. found that undulating type of lower border of mandible was found predominantly in males and straight border of mandible in females. Rocker shape of mandible was absent in their study.[3]

In the present study posterior borderramus flexure in males found to be either straight or is at the level of occlusal plane and in females ramus flexure is found at a level above the occlusal plane near condyle. At the time of growth spurt the mandible grows at a faster rate and the masticatory force and sex hormone plays an important role in the dimorphism of mandible.[11,12] Loth and Henneberg in Jordanian population found that ramus is flexed at the level of occlusal plane whereas in females it is straight or flexed near neck of condyle. According to them mandibular flexure is a single morphological indicator of sexual dimorphism with a predictive accura of 90.6 to 99.0%. The high level of ramus dimorphism can arise in response to sex specific hormones at puberty which targets receptors in mandible and it is also governed by the forces exerted by masticator muscles[11,13–15] Deana et al. couldn't found any statistical difference in the position of ramus flexure in males and females.[7] Panda et al. found that males show ramus notching at the level of occlusal plane while females have notch at the level above occlusal plane.[16] Donnelly et al. and Balci et al. found that males could be more accurately determined by following Loth's criteria.[17,18] According to Hill, mandibular flexure is not reliable for determination of gender.[19] James L et al. in south Indian population found that ramus flexure in males is at the level of occlusal plane and in females it is straight or at the level of condyle which is similar to the guidelines of Loth et al.[20] Table 4 shows the comparison of chin profile, base of mandible and mandibular ramus flexure in both males and females.

Skeletal characteristics can vary in different population, so there is a need for population specific standards.[21] Biological identity has four main attributes like sex, age, stature and ethnic background of individual which are called as 'Big Four' in forensic context.[22,23] Sexual dimorphism is population specific and can vary in different ethnic groups. So the degree and pattern of sexual dimorphism in one

Table 3: Gender * Ramus flexure

		Ramus flexure			Total	Pearson Chi-Square value	P value
		Ramus flexure absent	Ramus flexure present at the level of occlusal plane	Ramus flexure present at a level above occlusal plane			
Gender	Male	19	59	22	100	90.349a	P<0.01
	Female	9	4	87	100		
Total		28	63	109	200		

Table 4: Showing profile of chin, base of mandible and mandibular ramus flexure in males and females

S.No.	Non metric traits	Types	Males (n = 100)	Females (n = 100)
1	Profile of Chin	Straight	43%	16%
		Prominent	57%	84%
2	Contour of base of mandible	Straight	38%	67%
		Undulating	52%	33%
3	Mandibular Ramus flexure/ notch	Ramus flexure	19%	9%
		Ramus flexure at the level of occlusal plane	59%	4%
		Ramus flexure above the level of occlusal plane	22%	87%

population may not be accurate for another population.[3] Masticatory forces excerted by males are more compared to females and it can influence the shape of mandibular ramus.[24,25] In general, the overall size and bone thickness is greater in males than females. It is thought to be due to better nutrition and heavy physical activity.[25]

6. Conclusion

The results of the study show that is variation in the morphology of human mandible in males and females. Non metric traits are a better than metric traits for gender determination as it can be assessed easily and quickly. Larger sample size can be used to confirm the results so that it can be used as an adjunct in the forensic identification of gender from skeletal remnants of unknown individuals.

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8. Conflict of Interest

Nil.

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