

Coronoid process of mandible, a hidden tool in forensics

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Abstract

Introduction: Mandible plays a vital role in sex determination because of some special features like it is the most dimorphic, largest, strongest and mobile bone of skull. Gender of an unknown individual can be determined from the morphology and metric features of skull and mandible, soft tissues, as well as by DNA analysis of teeth. The variations in shape of coronoid process of mandible may acts as anthropological markers, to assess different populations & races.

Materials and methods: Eighty panoramic radiographs (160 sides) 40 males and 40 females were selected from the patients who reported in the Department of Oral Medicine and Radiology for treatment.

Results: In the present study it was found that most common type of the coronoid process in both genders was the triangular type followed by hook and rounded types. It was also found in the present study that the condylar height is more in males (average height in males is 60.55±5.6 mm.) than females (average height in females is 54.87 ±5.6mm).The right condylar process is longer (average height is 58.41±5.6 mm) than the left coronoid process (average height is 57.01±5.6 mm)

Conclusion Coronoid process is considered as one of the hidden tool in forensics which can be effectively used for the sex determination for medico legal purposes and maxillofacial surgeons and plastic surgeons for reconstructive purposes.

Keywords: Panoramic radiograph, Anthropological analysis, DNA analysis.

Introduction

Each and every human being has their own facial profile and external features which helps in identifying the gender of individual but the identification of an individual becomes very difficult during natural calamities (like earthquakes, tsunami like events, floods) and man-made disasters such as transport accidents, bombings and other terrorist activities. In such conditions, a scientific technique is essential for identification of an individual. Such scientific or primary methods which includes comparison of fingerprint patterns, medical and dental evidence and analysis of deoxyribonucleic acid (DNA).¹ Among human bones skull and pelvis are the most reliable source for determining gender of an individual. But in some cases intact skull is not available then mandible plays a vital role in sex determination because of some special features like it is the most dimorphic, largest, strongest and mobile bone of skull.^{2, 3} Gender of an unknown individual can be determined from the morphology and metric features of skull and mandible, soft tissues, as well as by DNA analysis of teeth.⁴ In young and adult human males there are significantly larger biting forces than females which could be due to the larger muscle mass in males. An increased muscle mass in male influences the facial morphology and thus the differential muscle mass in males and females could contribute to the sexual dimorphism. This could be an important differentiating factor that causes sexual dimorphism. The large muscle mass of the temporalis may explain the elongated coronoid process in the mandibular morphology of males.⁵

The aim of this study was to determine the gender of an individual on the basis of morphometric analysis of coronoid process and height of condylar process of mandible using digital panoramic radiographs.

Materials and Methods

This cross-sectional descriptive study was done in the Department of Oral Medicine and Radiology, Government Dental College Srinagar. Eighty panoramic radiographs (160 sides) 40 males and 40 females were selected from the patients who reported in our department for treatment. Standardized Digital Panoramic Radiographs were taken by Kodak Dicom 8000 system (tube potential: 60-90 KV, tube current: 2-15 mA, and time: 14 s). The magnification factor reported by the manufacturers was 1.2.

Inclusion criteria

1. Patients aged 20 years and above
2. Images with minimal technical errors, acceptable density and contrast, minimal structural super impositions
3. Coronoid processes of the mandibles were selected which were well formed in shape and size.

Exclusion criteria

1. Patients who have undergone surgical intervention in coronoid region
2. Patients with disorders affecting bone such as Paget's disease, fibrous dysplasia, and hyperparathyroidism
3. Patients with hemi facial malformations
4. Patients with previous history of trauma in orofacial region.
5. Patients with intraosseous lesions, orthognathic surgery, orthodontic treatment
6. The radiographs having deformed coronoid process were discarded.

For the measurement of the size of the coronoid process, the following points were marked

Point B on the lowest point of the mandibular notch. Note its distance from the base of the mandible. At the same height, a point A will be marked on the anterior border of the ramus of the mandible. A line will be drawn to meet these points. A point C will be marked on the top of coronoid process. Then a perpendicular CD will be drawn on the line drawn by meeting the points A and B. A triangle was made and all the three sides of the triangle and height of the perpendicular were measured and compared the distances of the coronoid processes of male and female mandibles for the estimation of sex of the mandible.

Condylar height

Distance from top of condylar process to the most protruding portion of the inferior border of the ramus.

The following measurements are,

AB= Distance from point A on anterior border of ramus to the midpoint B on sigmoid notch on left side

AC= Distance from Point A on anterior border of ramus to the point C at the tip of coronoid process on left side

BC=Distance from point C at the tip of the coronoid process to the midpoint B on sigmoid notch on left side

CD=Perpendicular distance from point C at the tip of coronoid process to the line joining point A on anterior border of ramus to midpoint B on sigmoid notch on left side.

HL =Height of condylar process on left side. Distance from top of condylar process to the most protruding point on ramus of mandible.

A'B' == Distance from point A' on anterior border of ramus to the midpoint B' on sigmoid notch on right side

A'C'= Distance from Point A' on anterior border of ramus to the point C' at the tip of coronoid process on right side
 B'C'=Distance from point C' at the tip of the coronoid process to the midpoint B' on sigmoid notch on right side
 C'D'=Perpendicular distance from point C' at the tip of coronoid process to the line joining point A' on anterior border of ramus to midpoint B' on sigmoid notch on right side.

HR =Height of condylar process on right side. Distance from the top of condylar process to the most protruding point on ramus of mandible.



Fig. 1:

Results

This study included panoramic radiographs of 80 patients, 40 males and 40 females with age range of 20 to 60 years. Table 1 shows age distribution with mean age in males is 34 years and mean age in females is 31.6years.

Table 1: Age distribution

Age (years)	Males		Females		P-value
	No.	%age	No.	%age	
< 20	9	22.5	10	25	0.231
20-29	13	32.5	14	35.0	
30-39	5	12.5	6	15	
40-49	5	12.5	3	7.5	
50-59	4	10	3	7.5	
≥ 60	4	10	4	10.0	
Total	40	100	40	100	

Table 2: Shows different shapes of coronoid process in males and females

	Males		Females		%
	Right side	Left side	Right	Left side	
Triangular	25	23	26	25	62%
Hook shaped	10	10	10	9	24%
Round	5	7	4	6	14%

Table 3: Shows average height of coronoid process in males and females

Males		Females	
Right	left	Right	Left
61.28±5.6	59.82±5.6	55.54±5.7	54.2±5.6

Table 4: Shows average lengths of each arm in mm of right and left coronoid processes measurements of triangles in male and female mandibles.

Sex	Left side				Right side			
	AB	AC	BC	CD	A'B'	A'C'	B'C'	C'D'
Males	15.35±2.8	9.8 ±2.2	12.5±2.9	11.5 ±3	15± 2.6	9.3± 2.6	11.3± 3	11.5 ±3.2
Females	14.3 ±2.2	8.5± 2.4	12.1 ±3	9.6 ±3	13.4 ±3	7.7 ±2.4	11.5±3.2	9 ±3.3

In the present study it was found that in both males and females most common type of the coronoid process is the triangular type present in 62% of cases. Second common type is hook shaped present in 24% of cases and third type of coronoid process is rounded type which is found to be present in 14% of cases (Table 2). It was found in the present study that the condylar height is more in males (average height in males is 60.55±5.6 mm.) than females (average height in females is 54.87 ±5.6mm) as muscle attachment is more prominent in male than female coronoid process as shown in table 3. The right condylar process is longer (average height is 58.41±5.6 mm) than the left coronoid process (average height is 57.01±5.6 mm) as shown in Table 3. Most of the persons eat and chew on right side and the pull by the right temporalis muscle causes the coronoid process to develop more on right side than the left side. Other sides of the coronoid process are also longer as side AB in male is 15.35± 2.8mm whereas in female it is 14.3±2.2 mm and side AC in male it is 9.80±2.2 mm and in female it is 8.50±2.4 mm, BC in males is 12.5±2.9 and in females is 12.1 ±3, CD in males is 11.5±3 and in females 9.6 ±3. All the sides of the coronoid process are longer in males than in females. It shows that the coronoid process in male is longer than the coronoid process of female. From the measurements of the coronoid process we can assess the sex the mandible even from its fragments by comparing the lengths of the coronoid processes of male and female.

Discussion

The word coronoid is derived from a Greek word 'korone' (meaning crow's beak) is a flat triangular piece of bone projecting upward from the anterior margin of the mandibular ramus.⁶ In the early stage of mandibular development coronoid or condylar process cannot be distinguished from each other. At 24 mm stage (55th day), these processes begin to be mapped out in membrane, and by 43 mm stage (70th day), it will take the form as bony processes. At around 13th week of intrauterine life, a strip of cartilage appears along the anterior border of coronoid process which is replaced by the membranous bone. This cartilage usually disappears before birth but can persist as subcoronoid sutures.⁷

The panoramic radiography in providing anatomic measurements has been recognized because of its accuracy. The main advantages of panoramic images are:

1. Broad coverage, low radiation dose, and less time required for image acquisition.
 2. Contrast and brightness enhancement and enlargement of images provide an accurate and reproducible method.
- The limitations of this technique are

1. Magnification and geometric distortion, however, the vertical dimension in contrast to the horizontal dimension is altered less.

Panoramic radiographic imaging technique remains as quite sensitive to positioning errors because of relatively narrow image layer.⁸

Shakya et al⁹ showed in their study that triangular shape was more common, followed by rounded, beak type are rare. Mahajan et al¹⁰ studied 164 mandibles (328 sides) in their study. They reported that hook shaped coronoid processes were found in 90 (27.43%), triangular in 160 (48.78%), and rounded in 78 (23.78%). In our study it was found that most common type of the coronoid process is the triangular type. It was present in 62% of cases. Second common type is hook shaped, which was present in 24% of cases and third type of coronoid process is rounded type which is found to be present in 14% of cases. The findings in our study are consistent with previous literature.

A study done on orthopantomographs by Rinki et al with a mean value of coronoid height in males and females is 62.28 ± 5.41 mm and 56.88 ± 4.80 mm which was found to be highly

Significant.¹¹ The similar findings were obtained in a study done by Sairamet al comparing the different mandibular measurements in which the coronoid height was found to be significant in gender determination with mean in males and females is 57.61mm and 53.15 mm on right side and 58.52mm and 53.40mm on left side.¹² In a study done by Samatha K et al the coronoid height was found to be non-significant and mean score for males is 57.85mm and 55mm in females.¹³ It was found in the present study that the condylar height is more in males (average height in males is 60.55±5.6 mm.) than females (average height in females is 54.87 ±5.6mm) and the right condylar process is longer (average height is 58.41±5.6 mm) than the left coronoid process (average height is 57.01±5.6 mm). These findings are consistent with findings reported in previous literature.

Conclusion

Knowing the various shapes of coronoid process and height of condylar process, present study may be very useful for maxillofacial surgeons, anthropologists and forensic experts. Coronoid process is considered as one of the hidden tools in forensics which can be effectively used for the sex determination for medico legal purposes and maxillofacial surgeons and plastic surgeons for reconstructive purposes as it is used as graft in reconstruction of osseous defects in oral and faciomaxillary augmentation, correlation of non-union fracture of the mandible.

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Conflict of interest

None.

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