Assessment Of Role Of Mandibular Ramus Morphometry In Gender Determination- A Radiological Study (OPG).

Dr.Vishalakshi N[1], Dr. Lipi Sisodia[2], Dr. Saba Khan[3], Dr. Tulika Sharma[4], Dr. Nishita Gautam[5], Dr. Shashikumar T[6], Dr. Sanjana Bandi[7]

[1]Postgraduate Student. Department of Oral medicine and Radiology, Darshan Dental College and Hospital, Loyara, Udaipur, Rajasthan. (Corresponding Author)
[2]Professor. Department of Oral medicine and Radiology, Darshan Dental College and Hospital, Loyara, Udaipur, Rajasthan.
[3]Professor and Head. Department of Oral Medicine and Radiology. Darshan Dental College and Hospital, Loyara, Udaipur, Rajasthan.
[4]Reader. Department of Oral Medicine and Radiology, Darshan Dental College and Hospital, Loyara, Udaipur, Rajasthan.
[5]Senior lecturer. Department of Oral Medicine and Radiology, Darshan Dental College and Hospital, Loyara, Udaipur, Rajasthan.
[6]Postgraduate Student. Department of Oral Medicine and Radiology, Darshan Dental College and Hospital, Loyara, Udaipur, Rajasthan.
[7]Postgraduate Student. Department of Oral Medicine and Radiology, Darshan Dental College and Hospital, Loyara, Udaipur, Rajasthan.

ABSTRACT

Background: Digital panoramic radiographs can be used to determine vertical height measurements of the mandible. Methods based on measurements and morphometric are accurate and can be used in determination of sex

Aim& Objectives: To assess the role of mandibular ramus morphometry in gender determination by a radiological study through OPG. To measure various parameters like Maximum and Minimum ramus breath, Projective height of the ramus, Condylar, coronoid height and the mandibular morphometric values in males and females respectively.

Methodology: A total 60 panoramic images (30 females and 30 males) patients aged between 20 and 80 years were evaluated. The student T test was determined to evaluate the correlation between the variables was used separately.

Results: The combined mean of maximum ramus breadth in right and left ramus of males and females is 45.30 mm and is 43.09 mm respectively. the combined mean of right and left minimum ramus breadth of males and females is 33.22 mm 31.56 mm respectively. the combined mean of right and left projective height ramus of males and females is 74.40 mm is 66.23 mm respectively. The standard deviation of coronoid height in males and females is 4.74 and 4.49. The p value is 0.0001 which is highly significant between males and females.

Conclusion: The present study concluded that mandibular measurements using panoramic radiographs were reliable for gender determination. According to the results obtained from our study we conclude that the projective height of the ramus is the most significant of all the parameters, which may be used for gender determination using the mandible.

Keywords: Mandibular ramus, sex determination, mandible.

Introduction

Forensic dentistry, a vital area within forensic science, involves the careful handling, examination, and presentation of dental evidence for justice.[1] This field has been essential in identifying victims and suspects in various cases, including mass disasters and organized crimes.[2] The identification of human skeletal remains is crucial, with sex determination being a primary step in the process. While the accuracy of sex determination can reach 100% with complete skeletons, fragmented remains present challenges due to the reliance on available skeletal components.[3]

Research shows that sexual dimorphism in the mandible is significant, particularly in the ramus and condyle regions, influenced by masticatory pressures.[4] Techniques such as orthopantomography (OPG) and other morphological analyses are employed to assess skeletal features for sex determination.[5] Digital panoramic radiographs enable precise measurements of the mandible's dimensions, particularly in the Udaipur population.[6] This study aims to evaluate various morphometric parameters of the mandibular ramus, such as maximum and minimum ramus breadth and condylar height, to enhance gender determination in forensic investigations. The findings will contribute to more reliable methodologies for identifying skeletal remains in forensic contexts.[7]

Aim and Objectives

To evaluate the role of mandibular ramus morphometry in gender determination through orthopantomography

(OPG). The objectives are to assess parameters including maximum and minimum ramus breadth, projective height of the ramus, and condylar and coronoid height. To compare the mandibular morphometric values between males and females.

Material and Methods

Methodology

This retrospective study, titled "Assessment of the Role of Mandibular Ramus Morphometry in Gender Determination: A Radiological Study (OPG)," was conducted using the digital database of the outpatient radiology section at the Department of Oral Medicine and Radiology at Darshan Dental and Hospital. Ethical clearance was obtained from the institutional ethical committee before commencing the study.[8]

Materials and Equipment

- Materials: Digital panoramic radiographs.
- Equipment: X Mind PANO D Plus digital panoramic system and DIGORA compatible system software version DFW 2.8.[9]

A total of 60 digital panoramic radiographs were selected from the radiology section, adhering to the following inclusion and exclusion criteria:

Inclusion Criteria:

- Patients aged over 18 years of both genders.
- Digital panoramic radiographs with a complete complement of teeth.[10]

Exclusion Criteria:

- Radiographs with positioning and magnification errors.
- Poor-quality panoramic radiographs showing bone abnormalities or lesions.
- Patients with a history of trauma or previous surgical treatment.[11]

The selected 60 radiographs were equally divided into two groups:

- Group A: 30 males
- Group B:30 females

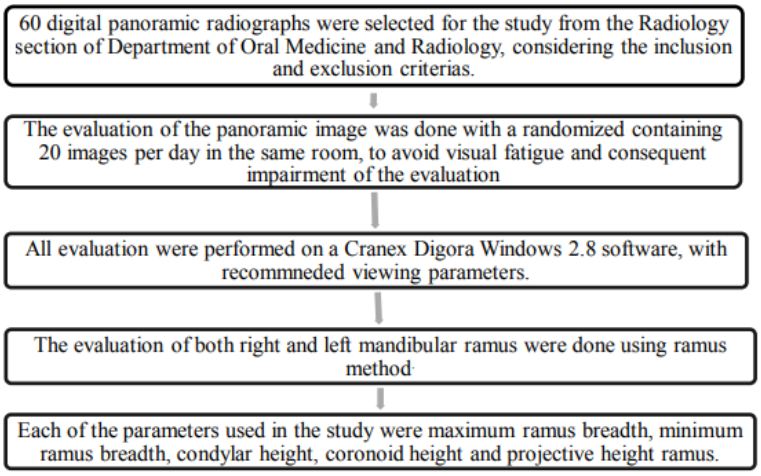
Each radiograph was examined digitally, focusing on the mandibular ramus, with measurements taken using the measurement tool in the system software. A magnification factor was considered during analysis. Measurements were performed using Cranex Digora for Windows version 2.8 (figure 1), in millimeters (mm), for both sides of the mandible employing the following parameters[12]:

1. Maximum Ramus Breadth (A): The distance from the most anterior point of the mandibular ramus to a line drawn from the most posterior point of the condyle to the angle of the jaw.[13]
2. Minimum Ramus Breadth (B): The smallest anterior-posterior diameter of the ramus.[14]
3. Condylar Height (C): The height of the ramus from the tubercle (the most projecting part of the inferior border) to the most superior point of the mandibular condyle.[15]
4. Projective Height of Ramus (D): The distance from the highest point of the mandibular condyle to the lower border of the mandible.[15]
5. Coronoid Height (E): The distance between the coronoid process and the lower border of the mandible.[16] (figure 2, 3, 4)

Statistical Analysis:

Data were entered into an Excel spreadsheet and analyzed using SPSS version 21. An unpaired Student's t-test was employed for comparative analysis. Results were presented as means, standard deviations, proportions, and percentages, with a p-value of less than 0.05 considered statistically significant.[17]

Schematic diagram of methodology



Results

The present retrospective study analyzed 60 Cone Beam Computed Tomography (CBCT) scans to evaluate various parameters of the mandibular ramus, sourced from the radiology section of the Department of Oral Medicine and Radiology at Darshan Dental College & Hospital, Loyara, Udaipur, Rajasthan. The participants were outpatients over 18 years of age, comprising both genders. The selected radiographs were divided into two groups for comparative analysis of five parameters. The Student's t-test was utilized for data comparison.

Gender Distribution:

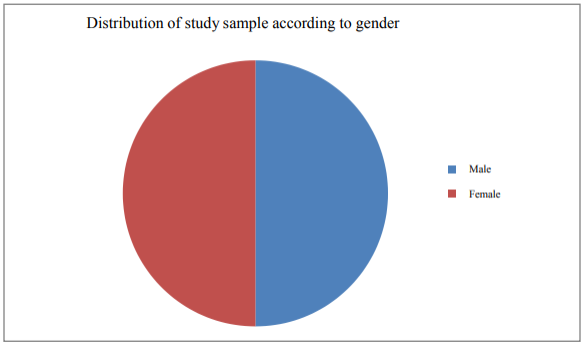
As shown in Table 1 and Graph 1, the study population consisted of 50% males (Group A) and 50% females (Group B).

Table: 1Shows distribution of study sample according to the gender.

Gender	Noofpatients	Percentage
Male (Group A)	30	50
Female (Group B)	30	50

Table 1 shows the percentage of study participants as male (Group A) was 50 % and females (Group B) was 50 %.

Graph: 1 Shows the distribution of study sample according to the gender.



Graph : 1 Shows equal distribution of the study sample according to gender is 50percent.

Maximum Ramus Breadth:

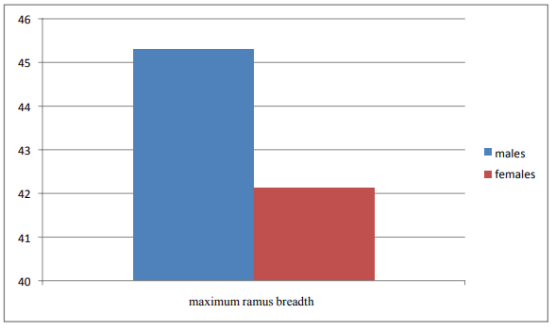
Table 2 and Graph 2 present the comparison of maximum ramus breadth between males and females. The maximum length of maximum ramus breadth measured on the right side for males (Group A) was 54.17 mm, while on the left side, it measured 50.46 mm. For females (Group B), the maximum length on the right side was 50.66 mm, and on the left side, it was 46.34 mm. The minimum length of maximum ramus breadth for males was 41.23 mm (right) and 37.01 mm (left), whereas for females, it was 34.13 mm (right) and 33.39 mm (left).

The mean maximum ramus breadth for males was 45.94 mm (right) and 44.34 mm (left), while for females, it was 42.6 mm (left) and 41.6 mm (right). The combined mean maximum ramus breadth for males was 45.30 mm and for females, 43.09 mm, with standard deviations of 4.06 and 3.59, respectively. The p-value of 0.0001 indicated a highly significant difference between genders.

Table 2 Shows comparison of maximum ramus breadth in males (Group A) and females (Group B).

Parameter	Groups	Right mean of max ramus breadth	Left mean of max ramus Breadth	Combined (right and left) mean	Standard deviation	P value
Maximum ramus breadth	Males	45.94	44.64	45.30	4.06	0.0001
	Females	42.61	41.63	42.12	3.59	0.0001

Table 2 Shows that the maximum ramus breadth is seen in males with the significant values seen around 0.0001.
Graph 2 Shows comparison of maximum ramus breath in males (Group A) and females (Group B).



Graph 2 Shows maximum value of maximum ramus breadth in males (Group A) (45.4mm) than females (Group B) (42.2 mm).

Minimum Ramus Breadth:

The comparison of minimum ramus breadth is detailed in Table 3 and Graph 3. The maximum length measured on the right side for males (Group A) was 38.77 mm, and on the left, it was 36.09 mm. For females (Group B), the maximum lengths were 40.41 mm (right) and 40.4 mm (left). The minimum lengths for males were 27.47 mm (right) and 25.05 mm (left), while for females, they were 26.69 mm (right) and 24.45 mm (left).

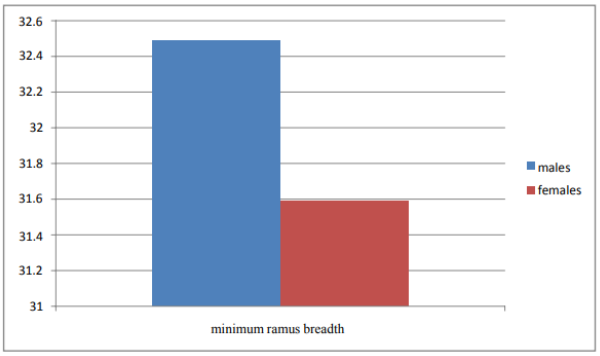
The mean lengths for males were 33.32 mm (right) and 32.3 mm (left), while for females, they were 31.95 mm (left) and 30.76 mm (right). The combined means were 33.22 mm for males and 31.56 mm for females, with standard deviations of 2.15 and 3.12, respectively. The p-value of 0.00001 confirmed a highly significant difference.

Table 3 Shows comparison of minimum ramus breadth in males(Group A) and females (Group B).

Parameter	Groups	Right mean of min ramus Breadth	Left mean of min ramus breadth	Combined (right and left) mean	Standard deviation	Pvalue
Minimumramus Breadth	Males	32.77	32.38	32.49	2.50	0.00001
	Females	31.95	30.76	31.56	3.12	0.0001

Table 3 Shows that the minimum ramus breadth seen in the males around 32.77 mm and with the standard deviation of 2.50 with the significant value of 0.00001.

Graph: 3 Shows comparison of minimum ramus breath in males (Group A) and females (Group B).



Graph 3 Shows maximum value of minimum ramus breadth in males (Group A) (32.5mm) than females (Group B) (31.5 mm).

Projective Height of Ramus:

Table 4 and Graph 4 illustrate the comparison of projective height of the ramus. The maximum length measured on the right side for males (Group A) was 87.41 mm and 84.84 mm on the left. For females (Group B), these lengths were 78.93 mm (right) and 79.12 mm (left). The minimum lengths for males were 64.48 mm (right) and 66.1 mm (left), while for females, they were 60.87 mm (right) and 58.75 mm (left).

The mean lengths for males were 75.20 mm (right) and 74.17 mm (left), whereas for females, they were 70.05 mm (left) and 67.87 mm (right). The combined means for males and females were 74.40 mm and 66.23 mm, respectively, with standard deviations of 5.43 and 5.60. The p-value of 0.0001 showed a highly significant difference between the genders.

Photograph 1: Panoramic digital X-ray machine with computer setup.

Figure 2: Linear measurements of mandibular ramus

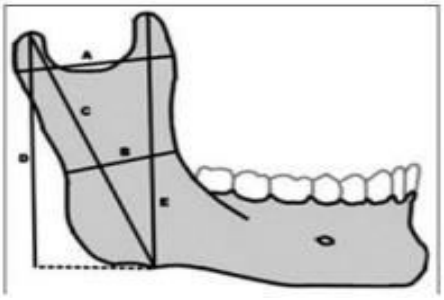


Figure 3: Female patient: Maximum ramus breadth, Minimum ramus breadth, Coronoid height, Condylar height and Projective height of the ramus.

Figure 4: Male patient: Maximum ramus breadth, Minimum ramus breadth, Coronoid height, Condylar height and Projective height of the ramus.

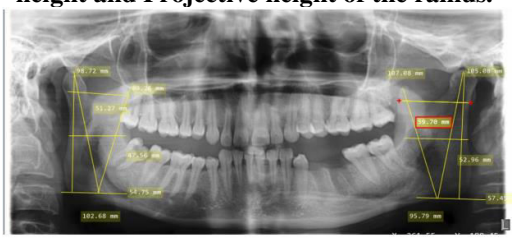
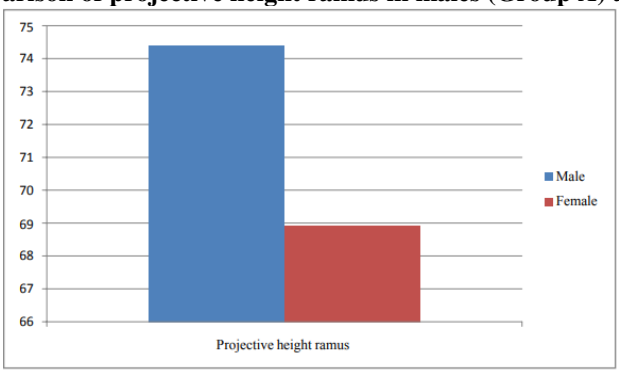


Table: 4 Shows comparison of projective height ramus in males(Group A) and females (Group B).

Parameter	Groups	Right mean of projective height ramus	Left mean of projective height Ramus	Combined (right and left) mean	Standard deviation	P value
Projective height Ramus	Males	75.20	74.17	74.40	5.43	0.0001
	Females	70.05	67.8	68.92	5.61	0.001

Table 4 Shows that the projective height ramus is seen in males in right and left side with the standard deviation of 5.43 mm and has a significant values.

Graph : 4 Shows comparison of projective height ramus in males (Group A) and females(Group B).



Graph 4 Shows maximum projective height ramus in males (Group A) (74.2 mm) thanfemales (Group B) (68.9 mm).

Condylar Height:

Table 5 and Graph 5 compare condylar height between males and females. The maximum length for males (Group A) was 84.65 mm (right) and 83.68 mm (left). For females (Group B), the maximum lengths were 75.33 mm (right) and 64.19 mm (left). The minimum lengths measured for males were 63.11 mm (right) and 66.1 mm (left), while for females, they were 55.56 mm (right) and 55.52 mm (left).

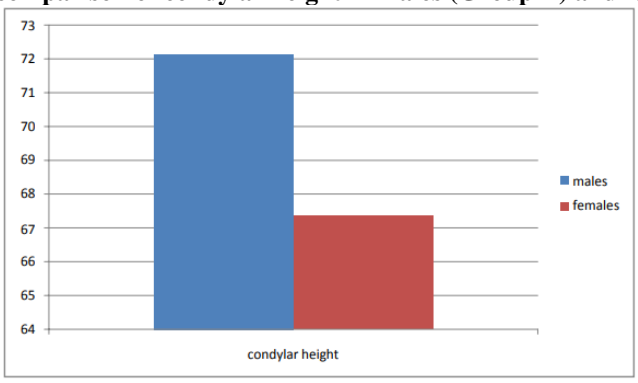
The mean condylar height for males was 73.38 mm (right) and 72.14 mm (left), and for females, it was 68.53 mm (left) and 67.35 mm (right). The combined means were 71.55 mm for males and 66.21 mm for females, with standard deviations of 5.61 and 4.90, respectively. The p-value of 0.0001 indicated a highly significant difference.

Table 5 Shows comparison of condylar height in males(Group A)and females(Group B).

Parameter	Groups	Right mean of condylar height	Left mean of condylar Height	Combined (right and left) mean	Standard deviation	Pvalue
Condylarheight	Males	73.38	72.14	72.76	5.61	0.0001
	Females	68.53	67.35	67.94	4.90	0.0001

Table 5 Shows that the condylar height is seen in males on panoramic radiograph on right and left side with the mean on 73.38 mm and 72.14 mm which is highly significant.

Graph : 5 Shows comparison of condylar height in males (Group A) and females (Group B).



Graph: 5 Shows maximum condylar height in males (Group A) (72.1 mm) than females(Group B) (67.4 mm).

Coronoid Height:

Finally, Table 6 and Graph 6 present the comparison of coronoid height. The maximum length for males (Group A) was 75.65 mm (right) and 75.69 mm (left). For females (Group B), these were 78.63 mm (right) and 79.12 mm (left). The minimum lengths for males were 55.90 mm (right) and 56.18 mm (left), while for females, they were 60.09 mm (right) and 59.41 mm (left).

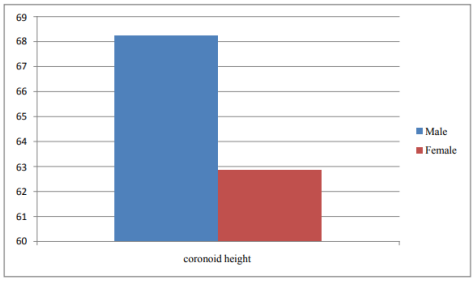
The mean coronoid height for males was 68.53 mm (right) and 67.72 mm (left), and for females, it was 68.83 mm (left) and 62.88 mm (right). The combined means were 67.24 mm for males and 61.63 mm for females, with standard deviations of 4.74 and 4.49, respectively. The p-value of 0.0001 demonstrated a highly significant difference between genders.

Table: 6 Shows comparison of coronoid height in males(Group A)and females(Group B).

Parameter	Groups	Right mean of Coronoid height	Left mean of Coronoid height	Combined (right And left)mean	Standard deviation	Pvalue
Coronoid height	Males	68.65	67.82	68.23	4.74	0.0001
	Females	62.83	62.88	62.85	4.49	0.0001

Table 6 Shows that the coronoid height is seen in males on right and left side which is 68.65 mm and 67.82 m which is highly significant.

Graph: 6 Shows comparison of coronoid height in males (Group A) and females(Group B).



Discussion

Identifying gender from human remains is crucial in forensic medicine and anthropology, especially for criminal investigations and understanding ancient populations.[18] The mandible is particularly significant for gender determination, especially in cases where the skull is fragmented or absent. Despite the existing literature, there is a notable lack of standardized measurements for the mandible, which remains largely intact in many cases.[19]

Panoramic radiographs are established as reliable tools for anatomical measurement. They offer several advantages, including broad coverage, low radiation exposure, and quick image acquisition.[20] Their digital formats also enhance image quality, making measurements more accurate and reproducible. However, panoramic radiographs do have limitations, such as magnification errors and geometric distortions, which can affect the precision of measurements.[21] Studies have shown that panoramic radiographs can be effectively used for evaluating the ramal height and

linear measurements in the horizontal plane, establishing their reliability in clinical settings.[22]

Most research has focused on individual morphological features of the mandible, such as the ramus, condyle, and coronoid process, rather than analyzing them collectively.[23] Our study aimed to fill this gap by evaluating several parameters on digital panoramic radiographs to determine which features are most significant for gender determination.[24]

Our study involved 200 patients, divided into two groups: Group A (males) and Group B (females). We measured five parameters: maximum ramus breadth, minimum ramus breadth, condylar height, projective height of the ramus, and coronoid height. Significant differences were found between males and females across all parameters, indicating strong sexual dimorphism.[25] While the mean values did not show significant differences for all parameters in previous studies, our findings aligned with established research indicating that specific mandibular sites exhibit significant gender variations.[26]

For instance, our results supported previous work by Giles et al. (1964)[27], which reported high significance in mandibular measurements, including ramus height and breadth, with an accuracy of 85%. In our study, the mean maximum ramus breadth was greater in males (45.31 mm) compared to females (43.09 mm), with the minimum ramus breadth also showing higher values in males (33.23 mm vs. 31.56 mm).[28]

Additionally, we observed that the projective height of the ramus was notably higher in males (74.41 mm) than in females (66.23 mm), reinforcing findings from Dayal et al. (2004)[29], which indicated that ramus height is a critical parameter for sex determination. These results confirm that mandibular features exhibit distinct sexual dimorphism, likely due to differences in musculoskeletal development between genders.[30]

Our study also revealed that the mean values of condylar height were higher in males (73.38 mm) compared to females (66.21 mm), consistent with earlier research that indicated significant dimorphism in these measurements. The findings related to coronoid height further support the notion that various morphological parameters are influenced by growth trajectories in males and females.[31]

In analyzing the influence of age on these parameters, we found no statistically significant differences across different age groups. This suggests that the identified sexual dimorphism in mandibular measurements remains consistent regardless of age, underscoring the potential of these parameters for reliable gender determination.[32]

Overall, our study confirms that maximum and minimum ramus breadth, condylar height, projective height of the ramus, and coronoid height are significant indicators of sexual dimorphism.[33] Among these, projective height of the ramus demonstrated the highest significant difference between genders.[34] These findings contribute valuable insights into the field of forensic anthropology and medicine, suggesting that a comprehensive assessment of mandibular parameters can enhance gender determination accuracy in forensic contexts.[35]

Conclusion:

This study aimed to evaluate gender variations in various morphometric parameters of the mandible among 60 subjects (30 males and 30 females) using digital panoramic radiographs. Following Institutional Ethical Committee approval, a complete clinical examination was conducted, and digital panoramic radiographs were obtained. Measurements were taken using reference lines drawn from anatomical landmarks with the X PANO D PLUS software. Five parameters were assessed on both sides of the mandible, and statistical analysis was performed using Student's unpaired t-test. Results indicated significant differences in maximum ramus breadth, minimum ramus breadth, condylar height, projective height of the ramus, and coronoid height, with the projective height of the ramus showing the highest significance for gender determination.[36, 37.]

Limitations

Difficulty assessing gender in edentulous patients and varying age groups, potential intra-observer variability, and focusing solely on mandibular landmarks.[38,39.]

Strengths of the study

Include a wide age range of participants and measurements taken on both sides of the mandible. Future research should involve larger, diverse populations and additional parameters for more definitive conclusions.[40]

References

1. Shamim T, Ipe Varughese V, Shameena PM, Sudha S. Forensic odontology: a new perspective. Medicolegal Update 2006; 6:1- 4

2. Shamim T. Forensic odontology. J Coll Physicians Surg Pak 2010;20:1-2.

3. Avon SL. Forensic odontology: the roles and responsibilities of the dentist. J Can Dent Assoc 2004; 70:453-8

4. Saini V, Srivastava R, Rai RK, Shamal SN, Singh TB, Tripathi SK. Mandibular ramus: An indicator for sex in fragmentary mandible. J Forensic Sci 2011; 56 (Suppl1):S13-6.

5. Scheuer L. Application of osteology to forensic medicine. ClinAnat2002; 15:297-312.
6. Franklin D, O'Higgins P, Oxnard CE, Dadour I. Discriminant function sexing of the mandible of Indigenous South Africans. Forensic Sci Int. 2008; 179:84.e1–5
7. Humphrey LT, Dean MC, Stringer CB. Morphological variation in great ape and modern human mandibles. J Anat. 1999; 195:491–513
8. Duric M, Rakocevic Z, Donic D. The Reliability of sex determination of skeletons from forensic context in the Balkans.Forensic Sci Int. 2005; 147:159–64.
9. Maat GJ, Maes A, Aarents MJ, Nagelkerke NJ.Histological age prediction from the femur in a contemporary Dutch sample. The decrease of non remodeled bone in the anterior cortex. J Forensic Sci. 2006; 51:230–7 References 57
10. Saxena S, Sharma P, Gupta N. Experimental studies of forensic odontology to aid in the identification process. J Forensic Dent Sci. 2010; 2:69-76
11. Sassouni V. Dentofacial radiography in forensic dentistry. J dent Res Jan./Feb.Supplement. 1963; 42(1):274–302.
12. Kahana T, Hiss J. Forensic radiology. Br J Radiol. 1999; 72:129–33.
13. Williams PL, Bannister LG, Berry MM. Gray's Anatomy. 38th Ed, New York, Churchill Livingstone; 2000:409- 19Sci. 2011; 56(Suppl1):S13–6.
14. Hu KS, Koh KS, Han SH, Shin KJ, Kim HJ. Sex determination using nonmetric characteristics of the mandible in Koreans. J Forensic Sci. 2006; 51:1376–82
15. Sweet.D Why a dentist for identification? Dent Clin North AM 2001; 15:237-51
16. Mahima VG. Mental Foramen for gender determination .A panoramic radiographic study Medico legal update 2009;9:33-35
17. Cagri Ural Cihan Bereket Ismail Sner,Ali Murat Aktan ,Yusuf, Ziya A of maxillary pinar .Bone height measurement of maxillary and mandibular bones in panoramic radiographs of edentulous patients. J Clinc Exp Dent 2011;3(1);5-9
18. Vodanovic M, Dumancic J, Demo Z Mihelic D.Determination of sex by discriminate functional analysis of mandibles from two Croatian archaeological sites. Acta Stomatol Croat 2006; 40:263-77
19. Frank R. Shroff, .Forensic odontology for the general practitioner Frank R. Shroff,- 58 References Australian Dental Journal ; Oct – Dec 1973
20. B.Rai, J. Kaur, Forensic Odontology: History, scope and limitations. Evidence based forensic dentistry, Springer- Verlag Berlin Heidelberg 2013
21. Panchbhai AS. Dental Radiographic indicators, a key to age estimation Dentomaxillofacial Radiology 2011; 40; 199-212
22. Text Book of Forensic Odontology –KMK Masthan, First Edition-2009, page no 24.64-65
23. Text Book of Forensic Odontology –Nitul Jain ,First edition -2013, page no 5-7, 67- 69.
24. Chandra Shekar BR, Reddy CV (2009) Role of dentist in person identification. Indian J Dent Res 20:356-360
25. Hinchliffe J.Forensic odontology part 1 Dental Identification. British Dental Journal 2011; 210:219-224
26. Whittaker DK, Rawle LW. The effect of conditions of putrefactions on species determination in human and animal teeth .Forensic Sci Int 1987; 35; 209-212
27. Giles E. Sex determination by discriminant function analysis of the mandible. Am J Phys Anthropol.1964; 22: 129–35.
28. Yaacob H, Narnbiar P, Naidu MDK (1996) .Racial characteristics of human teeth with special emphasis on the Mongoloid dentition. Malays J Pathol 18: 1-7
29. Mihai Dayal, Viorel Panaitescu, Mariana Rosu. Sex determination in Romanian mandible using discriminant function analysis: Rom J Leg Med [21] 305-308 [2013]
30 .Chandra A ,Bastian T ,Singh A ,Jaiswal R Chaudary S(2010) Establishment of gender in forensic odontology .Journal of Nepal Dental Association 11;78-81
31. Pretty IA and Sweet D.A look at forensic Dentistry Part 2; Teeth as weapons of violence –identification of bite mark perpetrators .Brit Dent J 2001;190:415-418
32. Strom F. Investigation of bite marks. J Dent Res. 1963; 42:312–6.
33. Shafer WG, Hine MG, Levy BM. Shafer's Textbook of Oral Pathology.5th Edition. Reed Elsevier India Pvt. Ltd. Philadelphia, 2006: 1199-1225.
34. Forensic Odontology .Forensic Medicine.
35. Ranganathan k, Rooban T, Lakshmminarayan V. Forensic odontology: review J Forensic Odontol 2008; 1:4-12
36. Lysell L. Plicae Palatinae transverse and Papilla incisive in man: A Morphologic and Genetic Study. Acta Odont Scand 1955; 13(1):135-37
37. Thomas CJ, Kotze TW., Jr The palatal rugae pattern in six Southern African human populations. J Dent Assoc S Afr. 1983; 38:547–53.
38. Augustine J, Barpande SR, Tupukari JV. Cheiloscopy as an adjunct to forensic identification: A study of 600 individuals. J Forensic Odontostomatol 2008;27:44-52. 60 References
39. Potsch L, Meyer U, Rothschild S, Schneider PM, Rittner C. Application of DNA techniques for identification using human dental pulp as a source of DNA. Int J Legal Med. 1992; 105:139–142
40. Sweet D, Lorente JA, Valenzuela A, Lorente M Villanueva E. PCR-based DNA typing of saliva stains recovered from human skin. J Forensic Sci. 1997; 42:447–51.