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Age and gender estimation by radiographic evaluation of mandible

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ABSTRACT

Aim and Objective: The aim of the study was to measure various morphometric parameters of mental foramen, height of ramus, mandibular canal, gonial angle and maxillary sinus in digital panoramic radiographs and to correlate these findings in the determination of Gender and Age.

Material and Methods: A total of 300 radiographs were reviewed for assessment of age and gender by evaluating mental foramen, mandibular canal, height of ramus, gonial angle and width of maxillary sinus in Digital Panoramic Radiograph.

Results: Among all the parameters changes in height of ramus, gonial angle and maxillary sinus was found to be highly significant (p value < 0.05) as age advances.

Conclusion: These parameters can be used to predict the age of the individual as there were significant changes in height of ramus, gonial angle and maxillary sinus. For further studies large sample size, and recent modalities in radiology like cone beam computed tomography or Computed tomography scan are required.

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1. Introduction

Forensic odontology is a branch of dentistry focused on the handling and analysis of dental evidence for identification purposes, particularly in mass disasters, criminal cases, and abuse situations. It plays a critical role in identifying victims and suspects, helping to deliver justice.[1] Similarly, oral medicine and radiology focus on diagnosing and managing diseases of the oral and maxillofacial regions, including age estimation through radiographic methods.[2] Key parameters for age estimation in radiographs include the formation of secondary dentin, changes in the orientation of the mental foramen and inferior alveolar canal, eruption of third molars, and patterns in the jawbone and pulp-to-tooth area ratio.[3]

Age assessment is often based on radiographic features of the mandible, such as the position of the mental foramen, which can provide a reliable estimate, especially during adolescence and early adulthood.[4] Third molars are particularly useful for this purpose, as they are highly variable but offer a biological indicator of age in the middle teens to early twenties. Comparing antemortem and postmortem radiographs is considered the most reliable method for identification.[5] Understanding the position and morphology of various anatomical structures in the mandible is essential in clinical dentistry, especially for procedures like local anesthesia, endodontic treatment, and age prediction.[6]

The mandible undergoes remodeling throughout life, influenced by factors such as age, gender, and dental health. Changes in structures like the mental foramen, mandibular canal, gonial angle, and maxillary sinus can

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be evaluated through radiographs, particularly panoramic X-rays (orthopantomograms).[7] The mental foramen is a hole in the mandible located near the premolars, and its position is crucial for correctly diagnosing pathologies and performing surgeries. While it can be identified radiographically, its variable location makes it important to understand its normal range when performing procedures like periapical surgery or regional anesthesia.[8]

The mandibular canal is another significant structure in the jaw that must be preserved during dental interventions.[9] It is crucial to avoid injury to the inferior alveolar nerve during procedures such as third molar extractions, implants, or jaw surgeries.[10] The mandibular condyle and ramus, in particular, are sites of significant morphological changes during growth and exhibit marked sexual dimorphism. Measurements of the mandibular ramus, which show a higher degree of sexual dimorphism than the mandibular body, are useful in forensic identification and determining sex.[11]

The mandibular gonial angle, an anthropometric measure, is used to assess growth patterns and is important for understanding craniofacial development.[12,13] Accurate assessment of the maxillary sinus is essential for surgeries like sinus floor elevation, and its distinct characteristics also make it valuable for human identification. The use of radiographs in forensic science dates back to 1896, shortly after the discovery of X-rays by Roentgen.[14] Dental radiographs are particularly useful in forensic identification, as they provide detailed information on tooth shape, root structure, missing teeth, fractures, and other abnormalities.[15,16]

Radiographic techniques, including conventional X-rays and more advanced imaging methods like computed tomography (CT), allow for detailed examination of the teeth and jaw.[17,18] CT scans provide cross-sectional images, making it easier to match antemortem and postmortem features. Digital techniques such as radio visiography enable accurate analysis of the spatial relationships between dental structures, enhancing the precision of forensic identification.[19] Specialized software can further align antemortem and postmortem images, eliminating the need for additional exposures and improving the accuracy of comparisons.[20]

Panoramic radiography is a widely used and cost-effective method in forensic odontology. It provides an image of both jaws with a relatively low radiation dose and in a short amount of time.[21,22] This technique is useful for identifying anatomical structures and assessing bony dimensions. However, panoramic X-rays are two-dimensional and can suffer from distortion, as they do not capture depth and magnify images both vertically and horizontally.[23] The magnification factors vary by machine, making it essential to consider these differences when interpreting the images.[24]

In summary, forensic odontology relies heavily on radiographic techniques for the identification of individuals, age estimation, and the analysis of anatomical structures in the mandible and maxilla.[24] The continuous development of imaging technologies, such as digital radiography and 3D imaging, has significantly enhanced the precision and reliability of forensic dental investigations, providing critical evidence in the pursuit of justice.[25]

Thus, remodeling of the mandible with age, gender and dental status also occurs throughout the life in many parameters such as mental foramen, mandibular canal, gonial angle, height of ramus and maxillary sinus. These changes can easily be identified and measured in orthopantogram.

2. Aim and Objectives

1. To measure various morphometric parameters of mental foramen, height of ramus, mandibular canal, gonial angle and maxillary sinus in digital panoramic radiographs.
2. To correlate these findings in the determination of gender and age.

3. Materials and Methods

The present study was conducted in the department of Oral medicine and Radiology at Sri Sai college of Dental Surgery, Vikarabad, India. This being a forensic and retrospective study panoramic radiographs were selected from the saved radiographs of past one year. Patients were divided into three groups based on age. Group A consisted of patients between the age group of 20 to 30 years, group B between the age group of 31 to 40 years and group C between the age group of 41 to 50 years. All groups had equal number males and females.

A sample of 300 antemortem orthopantograms were taken between the age of 20 to 50 years of age was selected for the study. The patients were exposed using carestream dental machine (serial number: BIAM 545). The images were acquired using dental imaging software with exposure parameters of 73 kVp, 12 mA and 13.9s from radiology department of the college. The digital panoramic images were saved after the exposure in which the measurements of mental foramen, mandibular canal, height of ramus, gonial angle and maxillary sinus were taken.

The mental foramen (Figure 1) was measured by drawing tangents along the lower border of body of mandible A perpendicular line was drawn from the lowest part of outline of the mental foramen to the tangent drawn along the lower border of the body of the mandible and the distance is measured from the mental foramen till the perpendicular line touching at the tangent at lower border of the mandible.

The mandibular canal (Figure 2) was measured along the course till mandibular foramen on the left side. To measure

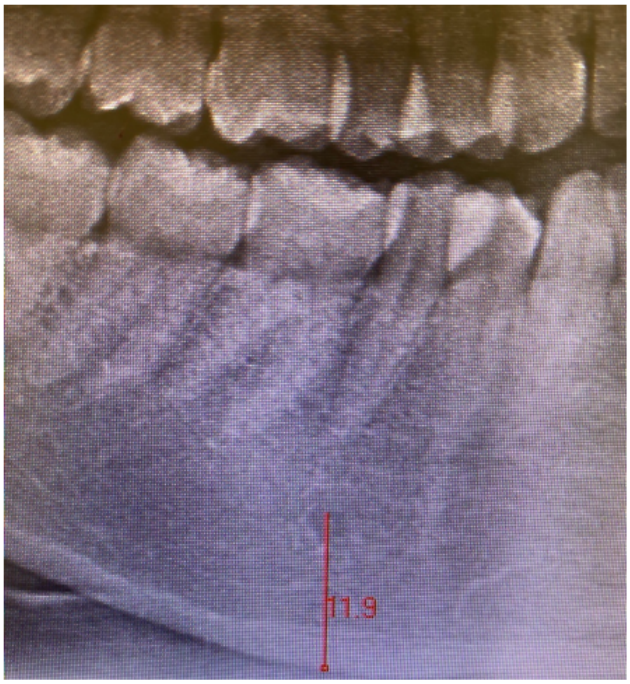

Figure 1: Mental foramen

height of ramus (Figure 3) the deepest point of sigmoid notch was taken at point A and a straight line was drawn till the inferior border of mandible.

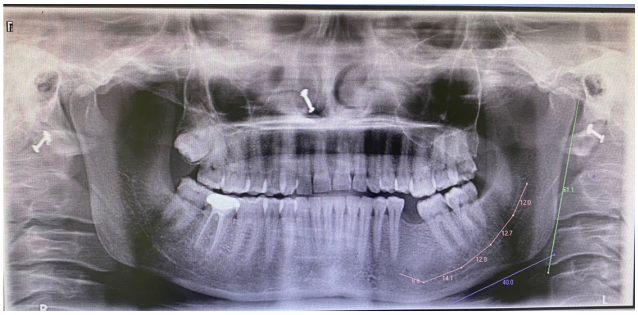

Figure 2: Gonial angle and mandibular canal

The gonial angle (Figure 2) was assessed by tracing a line tangent to the lower border of the mandible and another line tangent to the distal border of the ramus on each side. The intersection of these lines formed the mandibular angle.

Width of maxillary sinus (Figure 4) was assessed by drawing a straight line from the middle of the medial wall to middle of the lateral wall.

3.1. Inclusion criteria

1. Subjects between the age of 20 to 60.
2. Good quality standard panoramic images without any grade of exposure or positioning errors.

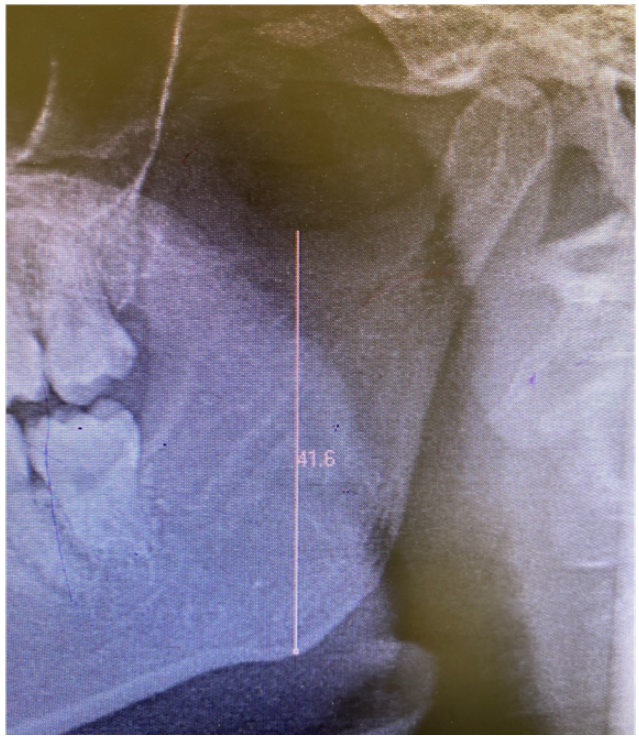

Figure 3: Height of ramus

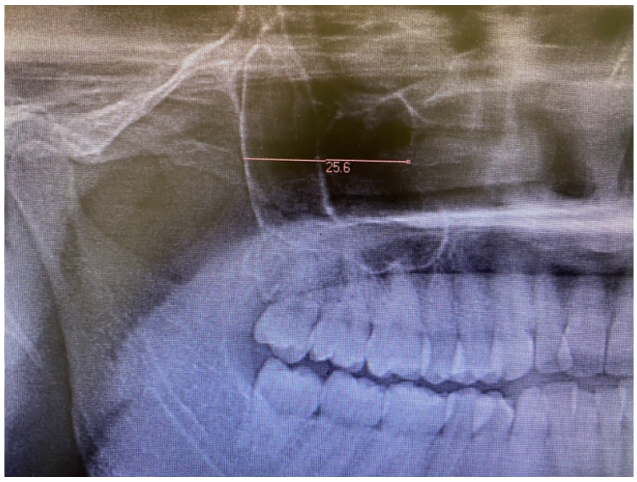

Figure 4: Right maxillary sinus

3. Radiographs without any pathologies, fractures, trauma to the mandible, structural deformities, developmental disorders of head and neck region.
4. Patients without any orthodontic treatment.

3.2. Exclusion criteria

1. Presence of pathological lesion, fracture of deformity
2. Age group <20 years and > 50 years
3. Presence of splinting, bone plates, lag screws

4. Presence of developmental anomalies or syndromes

4. Results

In the present study, the subjects were selected by random sampling method in which 63% were female and 37% were male.(Chart 1)

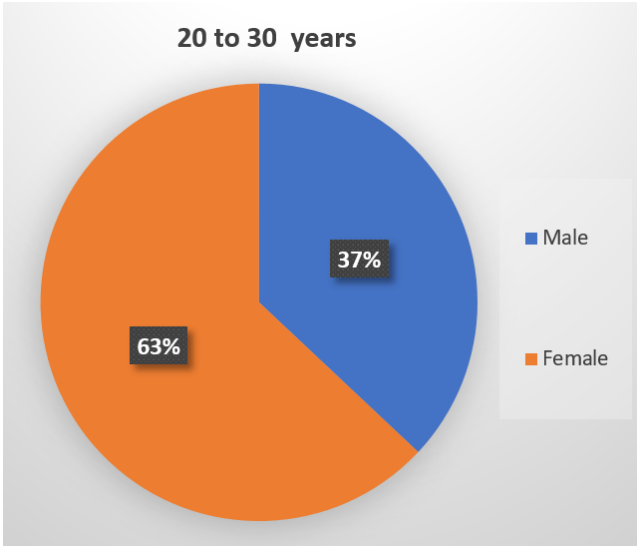

Chart 1: Distribution of subjects based on gender in group A

In the present study, the subjects were selected by random sampling method in which 50% were female and 50% were male.(Chart 2)

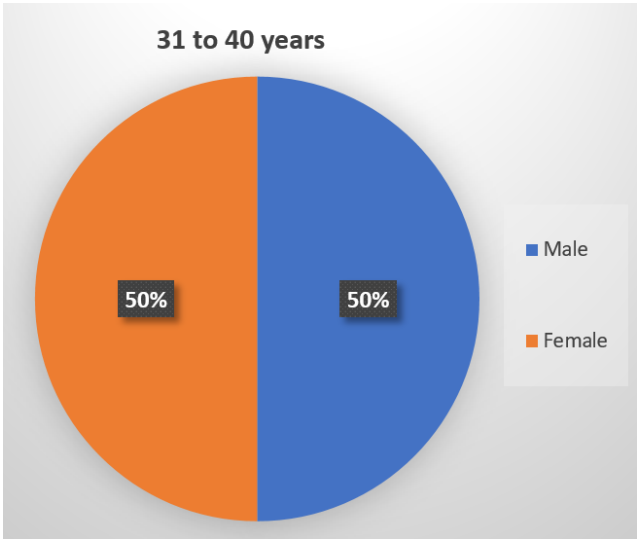

Chart 2: Distribution of subjects based on gender in group B

In the present study, the subjects were selected by random sampling method in which 46% were female and 54% were male. (Chart 3)

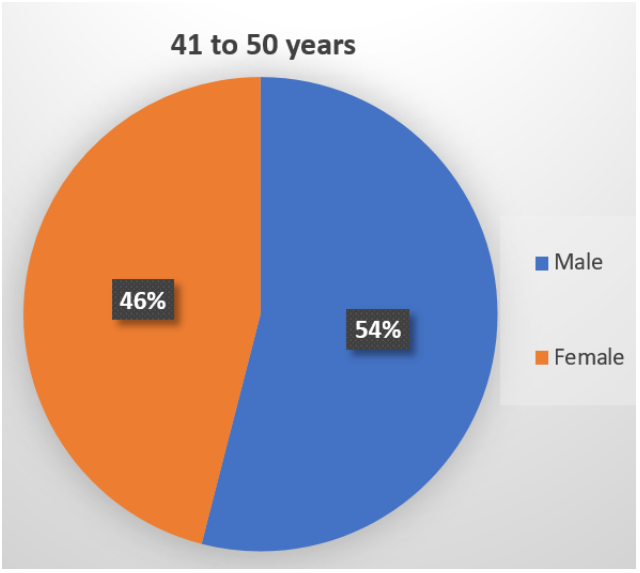

Chart 3: Distribution of subjects based on gender in group B

4.1. Distribution of subjects based on the parameters (Table 1)

1. Mental foramen: There was no significance seen in mental foramen with P value being 0.259 between the groups.
2. Mandibular canal:There was no significance seen in mandibular canal with P value being 0.147 between the groups.
3. Height of Ramus: Significance was seen in gonial angle with P value being 0.003 between the groups.
4. Gonial angle: Significance was seen in gonial angle with P value being 0.003 between the groups.
5. Right maxillary sinus: Significance was seen in right maxillary sinus with P value being 0.002 between the groups.
6. Left maxillary sinus: Significance was seen in left maxillary sinus with P value being 0.009 between the groups.

5. Discussion

What an evolution of dentistry for just managing tooth decay in ancient times to cosmetology, fighting cancer, and now to determine age and sex in forensic analysis.[26] It has happened not as a miracle but because of hard work put in by thousands of dentists for millions of hours for the cause of society in general and dentistry in particular.

Age estimation and sex determination are one of the important duties of medicolegal officers in recent times as crimes of varied nature are increasing.[26] Mandibular

Table 1: Distribution of subjects based on the parameters

				Mean Square	F	Sig.
Mental Foramen	Between Groups	(Combined)		59.139	1.356	.259
		Linear Term	Contrast	28.880	.662	.416
			Deviation	89.398	2.050	.153
	Within Groups			43.612		
	Total					
Mandibular canal	Between Groups	(Combined)		84.993	1.932	.147
		Linear Term	Contrast	165.802	3.768	.053
			Deviation	4.183	.095	.758
	Within Groups			44.000		
	Total					
Height of Ramus	Between Groups	(Combined)		25.141	1.341	.003
		Linear Term	Contrast	32.805	1.750	.187
			Deviation	17.476	.932	.335
	Within Groups			18.747		
	Total					
Gonial angle	Between Groups	(Combined)		464.520	6.002	.003
		Linear Term	Contrast	760.500	9.826	.002
			Deviation	168.540	2.178	.141
	Within Groups			77.397		
	Total					
Right Maxillary sinus	Between Groups	(Combined)		116.562	6.123	.002
		Linear Term	Contrast	185.859	9.763	.002
			Deviation	47.264	2.483	.116
	Within Groups			19.037		
	Total					
Left Maxillary sinus	Between Groups	(Combined)		73.289	4.743	.009
		Linear Term	Contrast	114.005	7.377	.007
			Deviation	32.573	2.108	.148
	Within Groups			15.454		
	Total					

condyle, ramus, gonial angle in particular are generally most sexually dimorphic as there are sites associated with greatest dimorphic morphological changes in size and remodelling during growth.

Cross-sectional studies have promoted the concept that mandibular ramus and angle could be used as an indicator of age and gender.

This study is in accordance with Ashima bali behl et al.[26] which showed gonial angle is influenced by both gender and age. the mandibular ramus showed a high sexual dimorphism with condylar and coronoid ramus heights as the most significant predictor for age and sex estimation.

Our results correlated with Huumonen et al.[27] who found significantly larger gonial angle in females as compared to males. Raustia and Salonen et al.[28] also showed no correlation of gonial angle with gender. Al-Faleh[29] could not establish any significant difference between sexes and gonial angle.

Our results did not correlate with studies by Shahabi et al. which showed no statistically significant difference between gonial angle of two sexes.[30]

Our study shows decrease in gonial angle with increasing age, intergroup analysis following a significant pattern which correlated with study by Upadhyay.[31] The width of maxillary sinus has been shown to decrease with age which is in accordance with the study done by Velasco-Torres M et al.[32]

Non significant differences were observed in vertical distance between inferior border of mental foramen and inferior border of body of mandible in all age groups (Table 1). According to this study the vertical distance between inferior border of mental foramen and inferior border of mandible should not to be studied further as it is showing non significant values. This distance is of least importance for determination of age.

6. Conclusion

From this study, we can conclude that for determining age three parameters can be used significantly which are vertical distance from sigmoid notch to lower border of body of mandible, gonial angle and width of right and left maxillary sinus. Panoramic being the easily available radiograph and easy to measure with less radiation to patients panoramic

radiograph was used.

To get accurate results anatomic measurements of all the parameters should be used instead of the panoramic radiographs because radiographs may show some magnification and angulation issues while taking images that will lead to fluctuated results.

To achieve high level of significance of results one should choose a large population which will also provide minimum number of errors and less biased results.

7. Source of Funding

None.

8. Conflict of Interest

None.

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